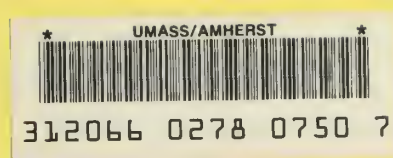


MASS. MFO3-2: N81



# CTPS TECHNICAL REPORT

# 50

## NORTH SHORE COMMUNITY COLLEGE TRAFFIC-IMPACT STUDY

GOVERNMENT DOCUMENTS  
COLLECTION

FEB 7 1986

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November 1985

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## SUMMARY

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The new North Shore Community College facility will be built in Beverly on a vacant site adjacent to Norwood Pond, one-half mile north of interchange 19 (Brimbal Avenue) of Route 128 (see Figure 1-1 on page 10). The college will serve 2,500 students and a faculty and support staff of 280. It is anticipated that over 5,500 vehicle-trips will be generated on an average weekday by this facility, which will have both day and evening classes.

Because the site for the new college is nearly land-locked, access is proposed to be via a new road built over Route 128 (and either over or intersecting Dunham Road, a local street which parallels Route 128) that will connect with local roads approximately three-fourths of a mile south of the campus. The new access road and its connections to local roads will be built to accommodate projected traffic volumes; however, existing roadways and intersections, including the Route 128 interchange, will remain unchanged.

The building of the access road and bridge will require land takings on the northern side of Route 128 (the southern segment will be built on an existing right-of-way). Another important consideration is access to the several businesses located on Dunham Road, one of which is Parker Brothers, which employs over 400 people at that site. Three versions of the college-access road have been developed for consideration. The versions vary in the land takings required and in the type of traffic flow permitted between Dunham Road and the new access road. Higher construction and right-of-way costs are associated with those versions of the access road which provide the most traffic mobility.

The traffic analysis presented in this document examined conditions in a base year of 1982 and a forecast year of 1987. Analysis of the forecast year included consideration of the impacts of both the new college and other local growth. The analysis focused on measuring congestion (in terms of service level, average vehicle-delay, and average queue length) at intersections for an AM (7:00-8:00 AM) and PM (4:00-5:00 PM) peak hour for each analysis year.

The term service level refers to a ratio of actual volume served to the ultimate capacity of an intersection. There are six levels of service--A, B, C, D, E and F--which can be equated to grades in school. At service level A, an intersection approach is serving a volume which is less than 5% of the capacity (95% of

the capacity is available). At service levels B, C, and D, this percentage is 10%, 30%, and 70% respectively. At service level E, 100% of the capacity of an approach to an intersection is being used. At service level F, there is more traffic than can be safely handled. Average vehicle-delay refers to the average length of time a vehicle must wait before being able to execute a maneuver. There is a direct mathematical relationship between service level and delay. Queue length refers to the number of vehicles waiting in line.

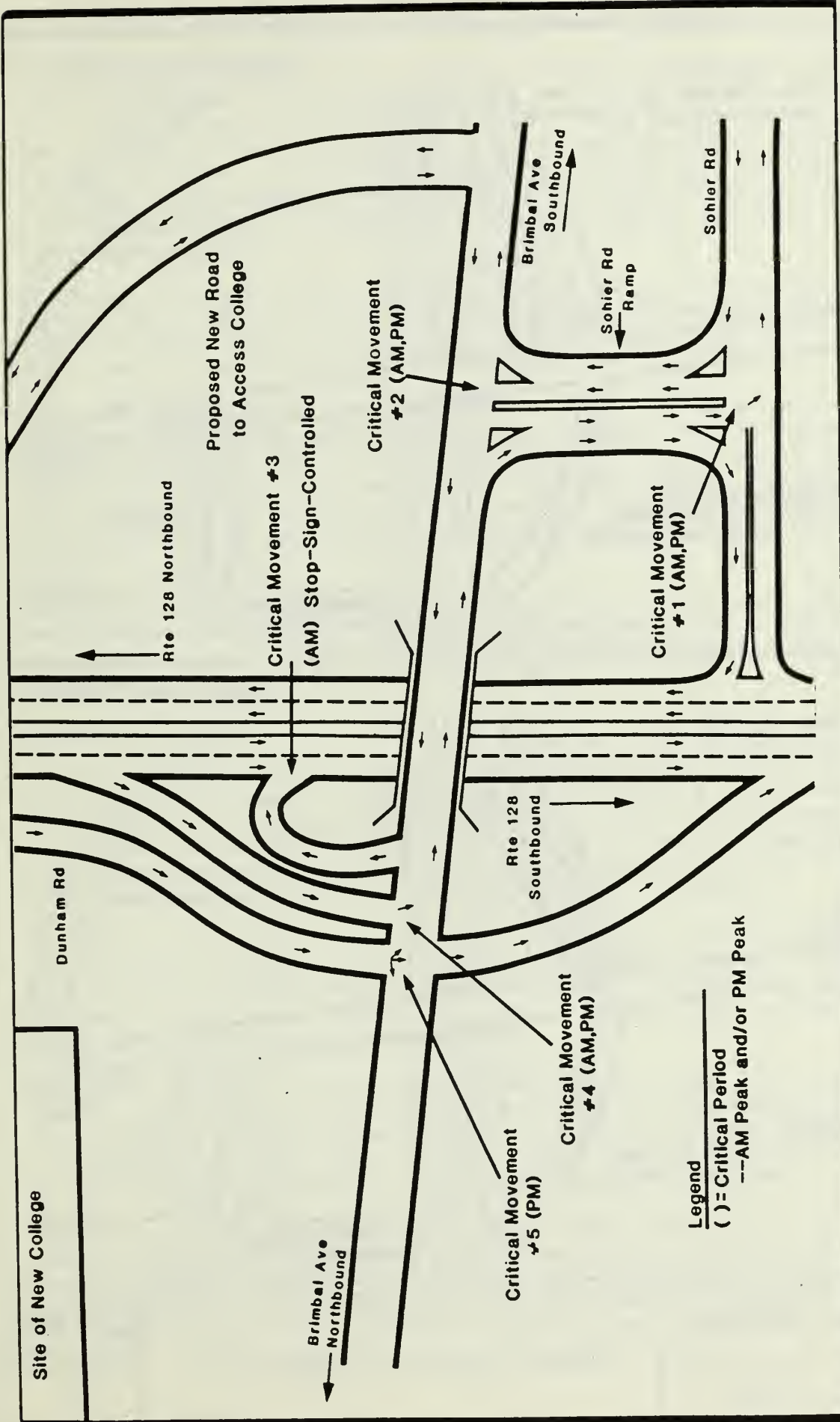
During field reconnaissance of the area, CTPS staff noted that the Route 128/Brimbal Avenue interchange is an old design and substandard by today's geometric criteria. Brimbal is the major road and all Route 128 ramps and side streets which intersect with Brimbal are stop-sign controlled. There is inadequate sight distance along Brimbal for vehicles egressing from several side streets. Vehicles moving between Brimbal and Route 128 do not have adequate acceleration or deceleration lanes. In the case of the Brimbal-northbound on-ramp to Route 128 southbound, vehicles face a stop sign at the end of the ramp and have no acceleration area on Route 128. In addition to these geometric problems, the area has many intersections operating at the E and F service levels during peak hours. Figure S-1 indicates the movements which operate at service levels E and F in the base year. Shown on the diagram is the period of failure (AM peak, PM peak, or both).

Based on the places of residence of students currently enrolled at the various existing campuses that are to be combined in the new building, it has been estimated that 72% of the traffic generated by the college will come from the south on Route 128, and 8% from the north on Route 128. Figure S-2 depicts the access routes to the college for Route 128 traffic under access options I and II and under option III. Under all options the intersection between the new access road and Brimbal Avenue appears to warrant signalization. As for the Brimbal Avenue/Route 128 interchange, each option impacts this interchange similarly in the AM peak hour. In the PM peak hour, the service levels change under each option since college egress varies.

The properties and traffic impacts of each access option are discussed below. This chapter concludes with Table S-1, which summarizes 1982 service levels and those that have been calculated for various possible circumstances in 1987.

#### Option I

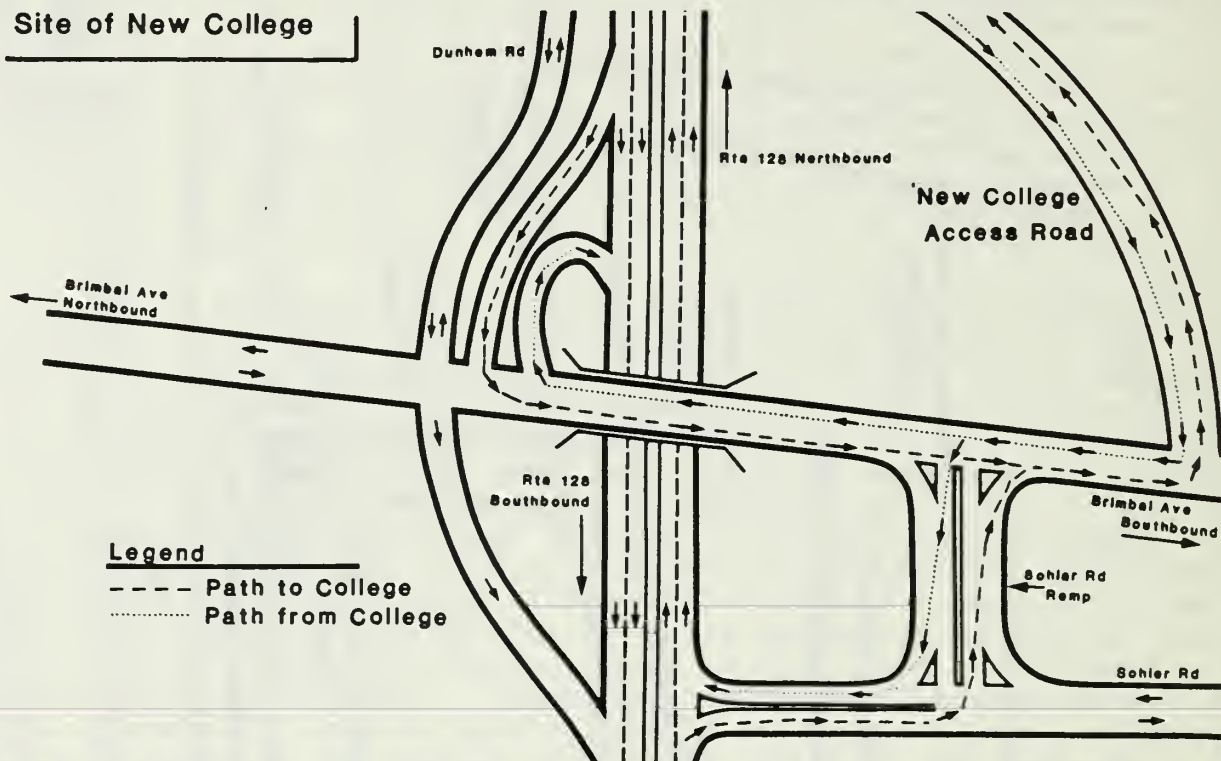
Under this option the new access road would bisect Dunham Road, the western section of Dunham would come to a dead end just west of the access road. The eastern section would connect to the access road with a "T"-type intersection. All of the traffic generated by the college and by the businesses on the eastern section of Dunham Road would use the new access road.



CTPS	FIGURE S-1	CRITICAL AREAS (SERVICE LEVEL E OR F)	<div data-bbox="1220 1862 1292 1937" data-label="Image"> </div> <div data-bbox="1234 1473 1263 1708" data-label="Text"> <p>NOT TO SCALE</p> </div> <div data-bbox="1311 1514 1380 1882" data-label="Text"> <p>Technical Report 50 November 1985</p> </div>

### Access Road Options I&II

Site of New College

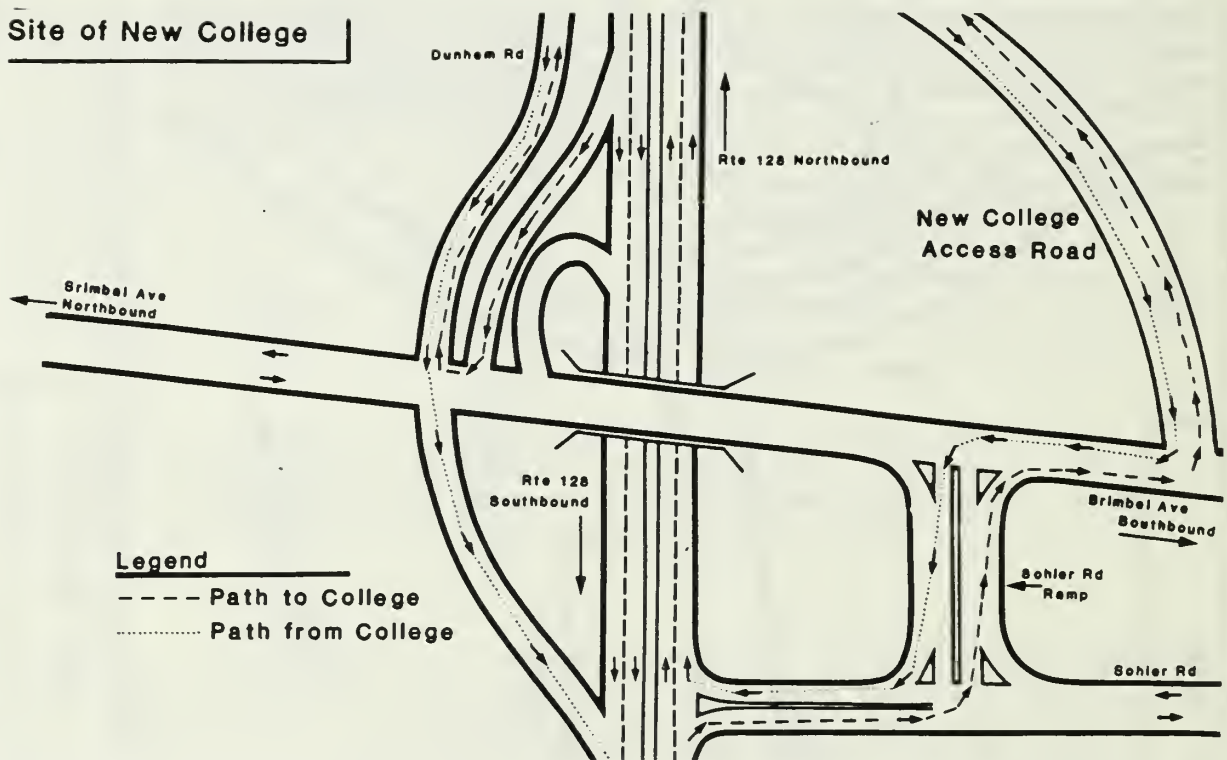


#### Legend

- Path to College
- ..... Path from College

### Access Road Option III

Site of New College



#### Legend

- Path to College
- ..... Path from College



NOT TO SCALE

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November 1985

COLLEGE ACCESS VIA ROUTE 128

**CTPS**

FIGURE  
S-2

In all three of the access options, critical movements #1 and #2 (see Figure S-1) would operate at a very poor level of service (F) in both the AM and PM peak hours. This is partially due to the college--without the college, the service level would vary between E and F. The college doesn't necessarily increase the volume of traffic making these movements, but it does increase the volume of traffic opposing these movements and thus increases the average vehicle delay.

Critical movement #3 would be operating at service level E in the AM peak with or without the college. In the PM peak hour, the traffic generated by the college would result in a decrease in the level of service of this movement from B to F.

Critical movement #4 would operate in the D-to-E range in 1987 without the college and without this option. With the college it would operate in the E-to-F range. This is due to the redirection of the Parker Brother's traffic (and traffic associated with other businesses on the eastern section of Dunham Road) and to the college traffic needing to travel south to reach the access road.

Critical movement #5 would improve under this option. It presently operates in the E range in the PM peak. It would be improved to the D range, since much of Dunham Road's traffic would be redirected to the access road.

## Option II

Under this option, a one-way road would be built under the college-access road. This one-way road would allow Dunham Road to be used to access businesses east of the college-access road on Dunham Road. All vehicles destined for the college would be required to use the new access road, as would all traffic leaving either the college or the eastern section of Dunham.

Critical movements #1 and #2 (see Figure S-1) would operate in the F range (as they would under all of the options under consideration). This is due to the increase in traffic volume for movements with which these conflict. Without the college, these movements would be in the E/F range.

As under Option I, critical movement #3 would be unaffected by the college in the AM peak, operating at service level E. In the PM peak this movement would operate in the B range without the college and without this option. With the college and access Option II, this movement would be at service level F.

Under Option II the southbound Route 128 traffic destined for Parker Brother's and other businesses on the eastern end of Dunham Road is allowed to take a right onto Brimbal Avenue and then a right onto Dunham Road. Without the college and without this option, critical movement #4 would be at service level E in

the AM peak and D in the PM. Options I and II reduce these levels to F and E, respectively.

As under Option I, Option II improves the service level at critical movement #5, reflecting the redirection of exiting traffic from the eastern end of Dunham Road to the new access road. Critical movement #5 would improve to the D range from its existing E level.

The high volume of traffic using the new access road will necessitate the signalization of the intersection created by the access road and Brimbal Avenue.

### Option III

This is the only option under which Dunham Road remains fully connected. The college-access road would be built over Dunham Road and a ramp would be provided between them. Under this option, traffic destined for either the college or businesses on eastern Dunham could use Dunham. Similarly, traffic leaving these areas could also use this road. This option diverts traffic from the new access road back to Dunham Road. The traffic volume on Dunham would increase by 18% over what it would be in 1987 without the college and this option. All of the traffic in Option I and part of it in option II is carried by the new access road. Dunham Road (critical movement #5--see Figure S-1) is over capacity in the base-year PM peak hour. This option would increase the PM-peak-hour volume by 48%, as compared to the 1982 base. The Dunham Road/Brimbal Avenue intersection cannot possibly support this traffic-volume level under its existing design.

Critical movement #3 would be at a better service level in this option than in Options I and II. In the PM peak hour in the base year, this movement is at service level B. Under Options I and II this movement in the PM peak would be at service level F. Under Option III this movement would remain at service level B. In the AM peak hour this movement is at service level E in the base year and is unchanged in Options I, II and III.

Critical movement #4 operates at service level E in the AM peak hour in the base year, and D in the PM. Under Options I and II the service levels would change to F and E, respectively. Under Option III, service levels would remain at E and D, respectively. These better service levels for Option III with respect to Options I and II reflect the reduction of traffic on Brimbal Avenue that would result from the college's and Parker Brothers' having two access/egress points (Dunham Road and the new access road).

As under Options I and II, in Option III critical movements #1 and #2 would operate in the F service-level range in both the AM and PM peak hours. The intersection between the new access road and Brimbal Avenue should be signalized under all three options.

			1987						
Critical Movement  Number	Description	Movement	1982 Base Year	No College No Local Growth	No College + Local Growth	With College/With Local Growth			
						Existing Network	Network Option I	Network Option II	Network Option III
	Brimbal Ave. at Dunham Rd.								
5.....	all of Dunham Rd		C(E)	C(E)	C(*F)	*F(*F)	C(D)	C(D)	D(*F)
	Brimbal lefts to Dunham		A(A)	A(A)	A(A)	C(A)	A(A)	A(A)	A(A)
	Brimbal lefts to Rte. 128		A(A)	A(A)	A(A)	A(A)	A(A)	A(A)	A(A)
	Sohier Rd. at Rte. 128 NB								
1.....	lefts to Sohier Rd.		*F(E)	*F(E)	*F(E)	*F(*F)	*F(*F)	*F(*F)	*F(*F)
	rights to Rte. 128		A(A)	A(A)	A(A)	A(A)	A(A)	A(A)	A(A)
	lefts to Brimbal Ave.		A(A)	A(A)	A(A)	B(A)	B(A)	B(A)	B(A)
	Rte. 128 SB at Brimbal								
4.....	lefts from Rte. 128		E(D)	E(D)	E(D)	*F(E)	*F(E)	*F(E)	E(D)
	rights from Rte. 128		A(A)	A(A)	A(A)	E(A)	A(B)	A(B)	A(A)
	Rte. 128 NB at Brimbal								
2.....	lefts to Brimbal		E(*F)	E(*F)	*F(*F)	*F(*F)	E(*F)	E(*F)	E(*F)
	rights to Brimbal		A(A)	A(A)	A(A)	A(A)	*F(B)	*F(B)	*F(B)
	lefts from Brimbal		A(A)	A(A)	A(A)	A(A)	A(A)	A(A)	A(A)
	College Rd. at Brimbal								
	lefts to Brimbal						*F(E)	*F(E)	*F(E)
	rights to Brimbal						A(*F)	A(*F)	A(A)
	lefts from Brimbal						*F(A)	*F(A)	*F(A)
	College Rd. at Parker Brothers Option I								
	lefts from P.B.						D(D)		
	rights from P.B.						A(A)		
	lefts to P.B.						A(A)		
	College Rd. at Parker Brothers Options II & III								
	lefts from P.B.							A(A)	E(A)
	rights from P.B.							A(A)	A(A)
	lefts to P.B.							A(A)	A(A)
	College Rd. at Dunham Rd. Option III								
	lefts to P.B.								A(A)
	rights to Dunham Rd.								A(A)
	lefts to College								A(A)

KEY

X = AM-peak-hour service level

(X) = PM-peak-hour service level

\*F = total failure. On the average, no acceptable gaps will ever occur. If a vehicle is waiting for an acceptable gap, it will wait for the entire peak hour. The vehicle must therefore accept a gap which is unsafe.

NSCC Traffic-  
Impact Study

Technical Report 50  
November 1985

SERVICE-LEVEL SUMMARY

CTPS

TABLE

S-1



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## 1 INTRODUCTION

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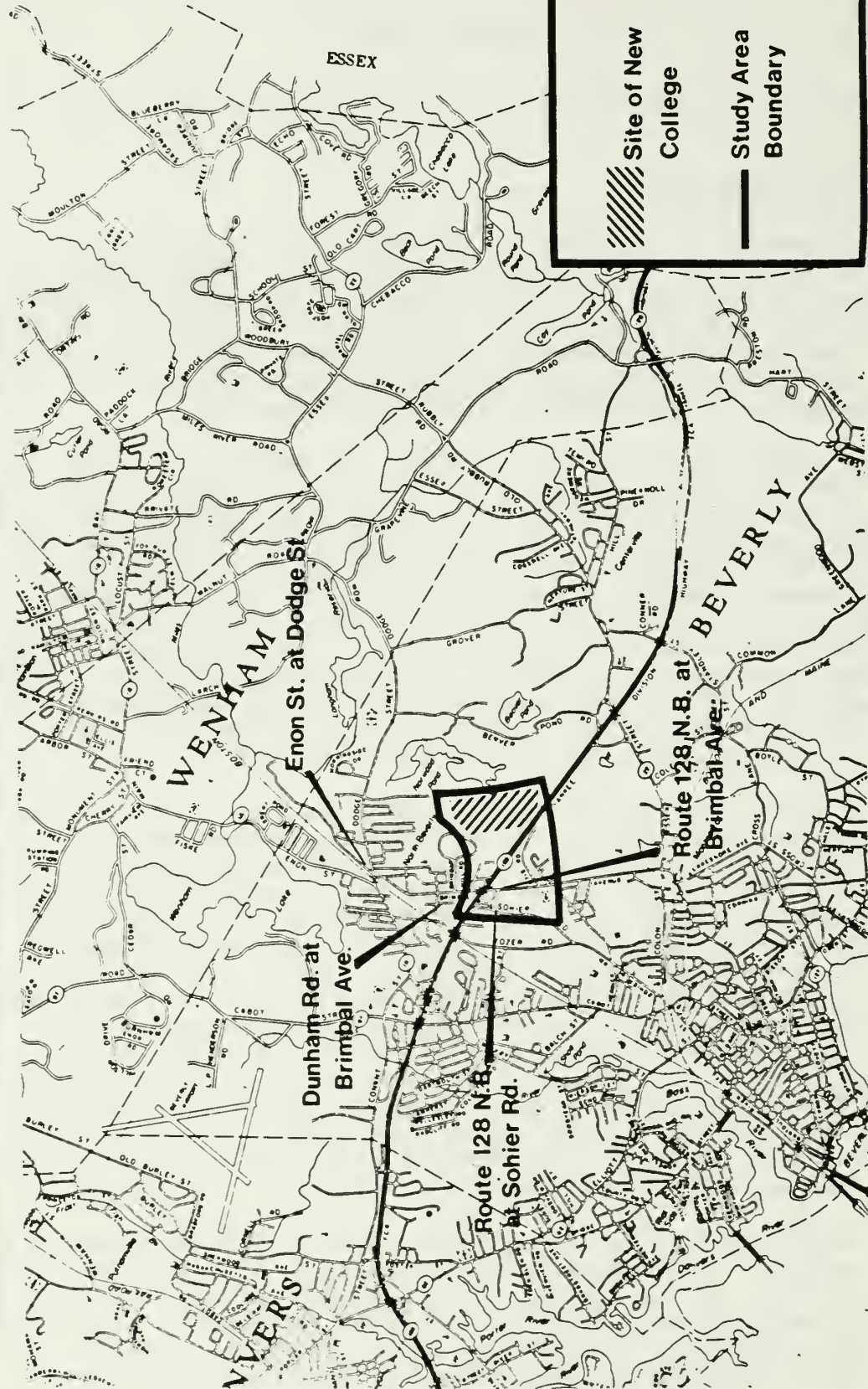
### 1.1 PROJECT DESCRIPTION

North Shore Community College was founded in 1965 and has been temporarily housed in the former Briscoe Junior High School on Essex Street in Beverly. In 1966, a report was prepared which identified six possible sites for the permanent location of the college. The Beverly/Norwood Pond site was selected (see Figure 1-1) and, following five years of negotiations, transfer of the land was made to the Commonwealth of Massachusetts.

Through the 1970s, very little progress was made toward the college's construction, and it was not until the early 1980s that the project was moved beyond the planning stage and given serious construction consideration. In 1982 a new master plan for the college site was completed by the Architects Collaborative of Cambridge, Massachusetts. The new plan calls for a 356,700 gross-square-foot structure to house 2,500 students, 182 faculty, and 100 administrative and support staff. The structure will be three levels arranged in a quadrangle fashion with three court-yards. Parking will be provided on-site for approximately 1,200 cars in a single lot. Total construction cost for the campus portion of the project is estimated at \$37 million.

An issue of long standing has been access to the site when the college is finally occupied. In addition, a separate issue is site access during construction. Currently the only direct access to the site is via a narrow strip of land which extends from Dodge Street along a row of residences to the northwest corner of the site (see Figure 1-2, lower left-hand corner of map). This access corridor is approximately 24 feet wide at its narrowest point and approximately 450 feet long. In the transfer of the parcel deed to the Commonwealth of Massachusetts, the state was precluded from accessing the site via many local (residential) streets. Access to the site via a direct connection with Route 128 has been ruled out by the Federal Highway Administration because of the close proximity of the proposed site access road to the Brimbal Avenue interchange to the south and the Essex Street interchange to the north.

The only viable access option appears to be a modification of a proposal made by the Massachusetts Department of Public Works in the early 1970s. The original MDPW proposal called for an access road to the college extending from Brimbal Avenue and generally following the existing road to the Beverly landfill, then crossing Route 128 east of the Route 128 service plaza and



CTPS

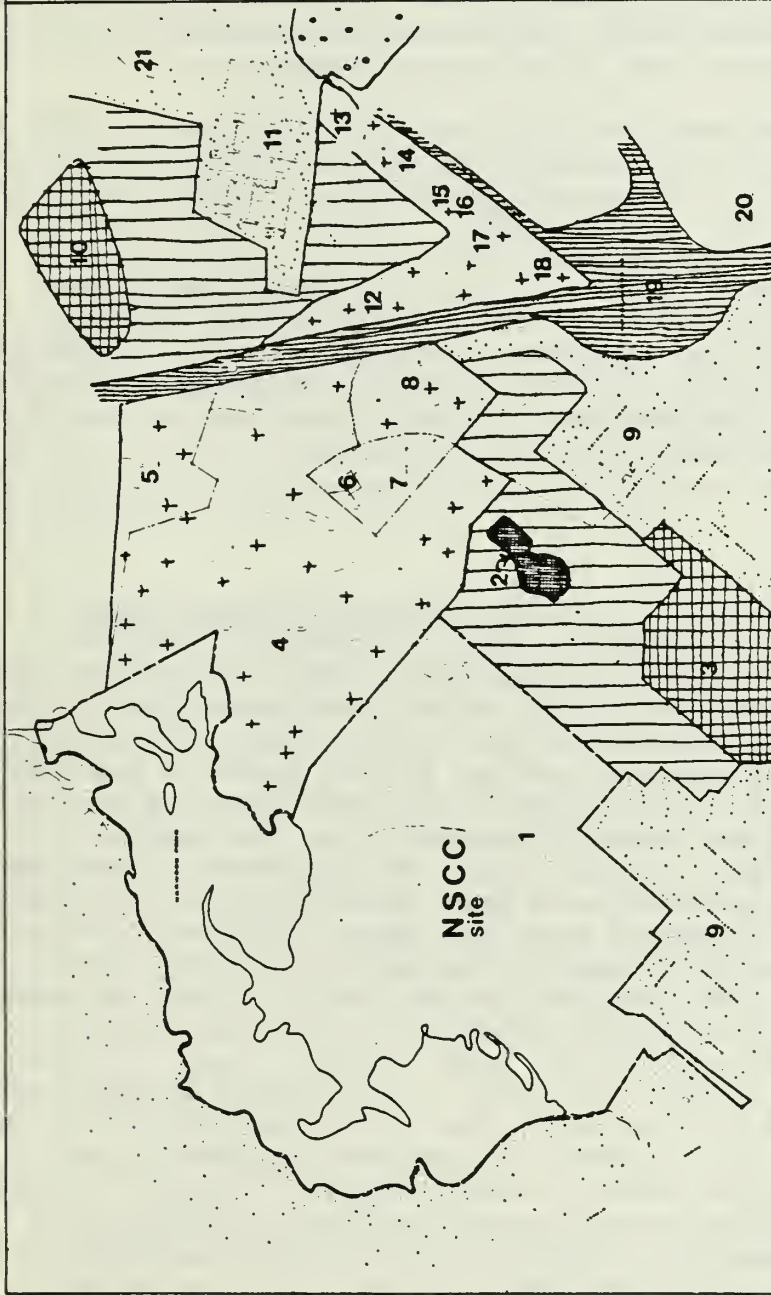
FIGURE  
1-1

LOCATION MAP

1" = Approx. 6 Mi.

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# **NORTH SHORE COMMUNITY COLLEGE AND ACCESS ROAD EIR/EA**

Norwood Pond Campus

Massachusetts Division of  
Capital Planning and  
Operations

Anderson-Nichols  
& Co., Inc. 1983

**Figure 10 LAND USE**

- |  |                            |  |                           |
|--|----------------------------|--|---------------------------|
|  | commercial                 |  | undeveloped               |
|  | residential                |  | cemetery                  |
|  | institutional/<br>landfill |  | land use parcel<br>number |
|  | water supply               |  |                           |
|  | transportation             |  |                           |

North Shore Community Col-  
lege Traffic-Impact Study

Technical Report 50  
November 1985

**CTPS**

**FIGURE**  
1-2

LAND USE

passing through the middle of a vacant tract of land between Dunham Road and the campus site. In 1974 Parker Brothers began construction of corporate headquarters (totaling 100,000 square feet by 1982) on the vacant parcel cited above. The construction by Parker Brothers precludes construction of the original DPW alignment. The latest proposal for access follows, to a degree, the original MDPW alignment, but the alignment would follow the southern boundary of the Parker Brothers property.

In April of 1982 the Secretary of the Executive Office of Environmental Affairs of the Commonwealth of Massachusetts ruled that the North Shore Community College project does require the preparation of an Environmental Impact Report (EIR). Anderson-Nichols & Company, Inc. was retained by the Massachusetts Division of Capital Planning and Operations to prepare the EIR, with the Central Transportation Planning Staff to prepare the traffic analysis. Staffing problems prevented CTPS from being involved in the project at that time. In May of 1983, Anderson-Nichols submitted their portion of the EIR in draft form and it was rejected for not including the traffic analysis.

## 1.2 CTPS ROLE

CTPS entered into a contract, through the Metropolitan Area Planning Council, with the Massachusetts Division of Capital Planning and Operations (DCPO) in December 1983, to conduct the traffic analysis. In the draft EIR, three site-access options were presented. Each of these options follows the MDPW alignment discussed above. Each alignment varies in the type of connection it will have with Dunham Road and thus each alternative has different traffic patterns and turning movements. Although the exact alignment of the access road under each option is not known (and several alignment options have been suggested for at least one of the options), it appears that the exact alignment will not influence traffic patterns or turning movements. These are influenced primarily by the type of connection provided between the proposed college connector road and the existing network.

CTPS responsibilities include the traffic analysis of the area, based on data collected by the MDPW, for existing conditions and for the college with each of three site-access options. Local growth was also to be considered in the analysis, which included the calculation of service levels, average vehicle delay, and average vehicle queue length. Figure 1-1 defines the boundaries of the study area and identifies key intersections to be analyzed.

Two additional issues were also to be addressed by CTPS as part of the analysis. These issues are:

1. The quantification of traffic impacts to the intersection of Enon, Dodge, and Laurel streets. This intersection is outside the boundary of the study area but its analysis was requested by the DCPO.
2. The changes in service level and the traffic disruption which could occur due to construction equipment accessing the college site. The college-access road will not be available during much of the college construction. Temporary site access has been proposed to be via Dunham Road. The impacts of this site-access option on traffic flow were to be addressed.

### 1.3 EXISTING LAND USE

Included in this report are Figure 10<sup>1</sup> and Table 12 from the draft EIR prepared by Anderson-Nichols & Company, Inc. (see Figure 1-2 and Table 1-1). This material describes the land use in the vicinity of the new college site and is included here to facilitate an understanding of the area without constant reference to the original draft EIR.

### 1.4 SITE-ACCESS ALTERNATIVES

The draft EIR prepared by Anderson-Nichols contained descriptions and sketches of each of the three site-access options. The exact alignment of each option is not known at this time, and several versions of each option may be possible. However, a deviation of several hundred feet in the alignment will not have an impact on the traffic volumes which each could carry. The major factor which influences the traffic volumes assigned to each option (as stated earlier) is the type of connection the option will have with local roads. Sections 3.3.5 through 3.3.7 of the draft EIR discuss the various access options and have been reproduced below, along with Figures 5, 6 and 7 from the draft EIR, which illustrate these options (see Figures 1-3, 1-4, and 1-5). In reviewing the options, note the various scenarios for connections with Dunham Road.

#### Access Road Option I

Access Road Option I calls for a limited access road running approximately 2,750 feet from Brimbal Avenue

---

<sup>1</sup>Anderson-Nichols & Company, Inc., North Shore Community College and Access Road EIR/EA, Draft Report, 1983.

<sup>2</sup>Ibid.

<u>Map Number*</u>	<u>Parcel Description</u>	<u>Type of Use</u>
1	NSCC - Norwood Pond Site	Institutional
2	Beverly Reservoir	Utility
3	North Beverly Elementary School	Institutional
4	Parker Brothers	Commercial
5	North Shore Music Circus	Commercial
6	Continental Cable Vision, Inc.	Commercial
7	E. Spear Trucking Company	Industrial
8	Beverly-Peabody Times	Commercial
9	Residential Housing	Residential
10	City of Beverly Landfill	Waste Disposal
11	Windsor Courts Apartments	Residential
12	Route 128 Service Plaza	Commercial
13	RDI-Recreation Park/Motorcycles	Commercial
14	Santin Engineering	Commercial/Office
15	Gulf Service Station	Commercial/Service
16	Sunoco Service Station	Commercial/Service
17	Stocker & Yale, Optics	Industrial
18	Vittori, Rocci Post (VFW)	Institutional
19	Route 128 Interchange 19	Transportation
20	Varian (Manufacturing)	Industrial
21	Blueberry Hill, Health Care	Health Care/Residential

\*For location of parcel see Figure 1-2.

Source: Anderson-Nichols & Co., Inc., North Shore Community College and Access Road EIR/EA, Draft Report, 1983, p. 40.

NSCC Traffic- Impact Study	KEY LAND-USE PARCELS	<b>CTPS</b>
Technical Report 50 November 1985		TABLE 1-1

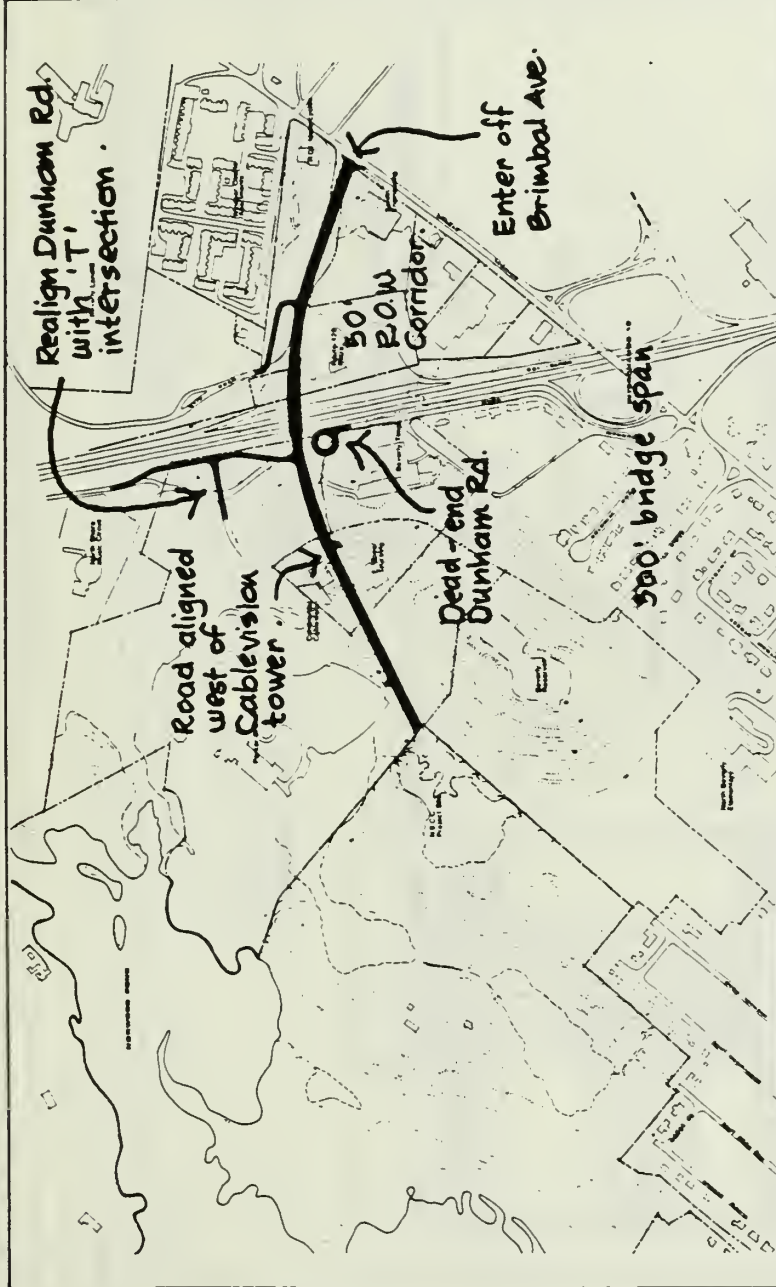


Figure 5 ACCESS ROAD OPTION I

**NORTH SHORE COMMUNITY COLLEGE  
AND ACCESS ROAD EIR/EA**

Norwood Pond Campus

Massachusetts Division of  
Capital Planning and  
Operations  
source: Mass DPW,  
Anderson-Nichols, 1983  
no scale

Anderson-Nichols  
& Co., Inc. 1983



North Shore Community Col-  
lege Traffic-Impact Study

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**CTPS**

**FIGURE**

1-3

ACCESS-ROAD OPTION I

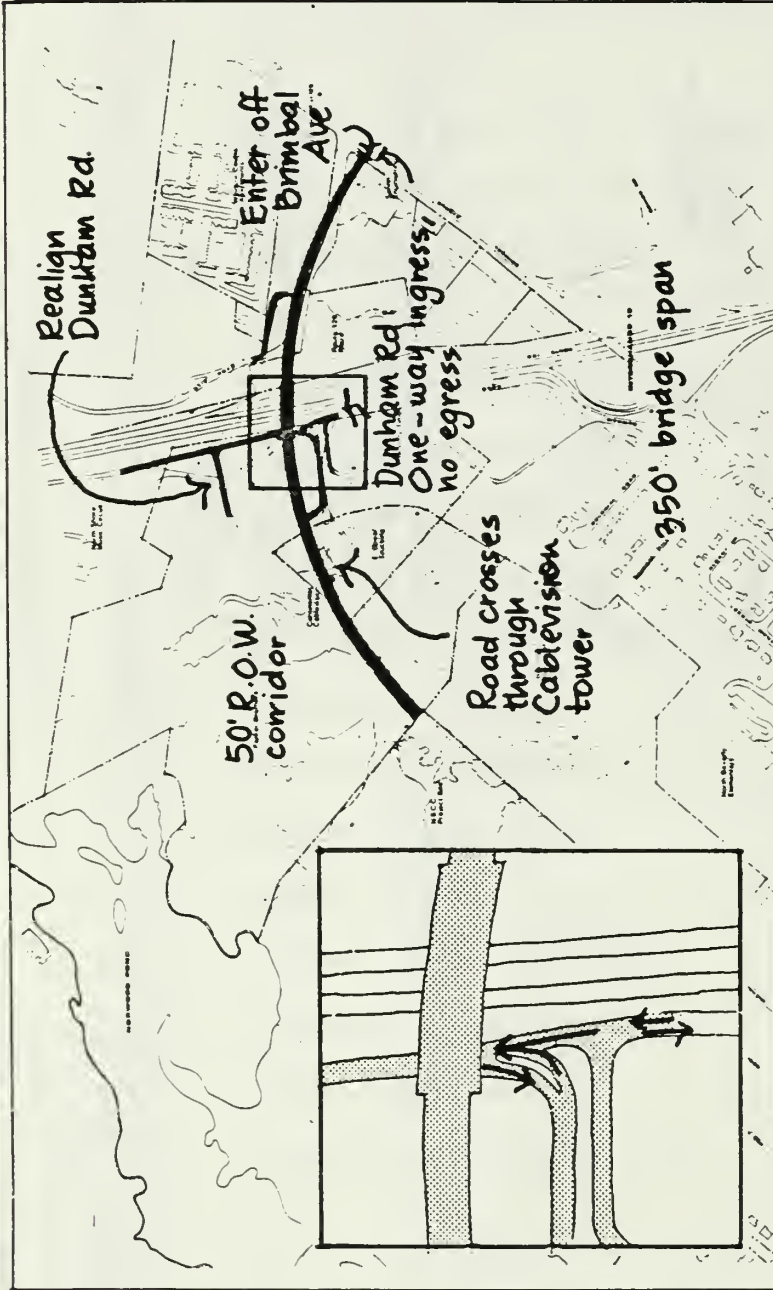


Figure 6 ACCESS ROAD OPTION II

**NORTH SHORE COMMUNITY COLLEGE  
AND ACCESS ROAD EIR/EA**

Norwood Pond Campus

Massachusetts Division of  
Capital Planning and  
Operations

Anderson-Nichols  
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source: Mass DPW,  
Anderson-Nichols, 1983  
no scale



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ACCESS-ROAD OPTION II

**CTPS**

**FIGURE**

1-4

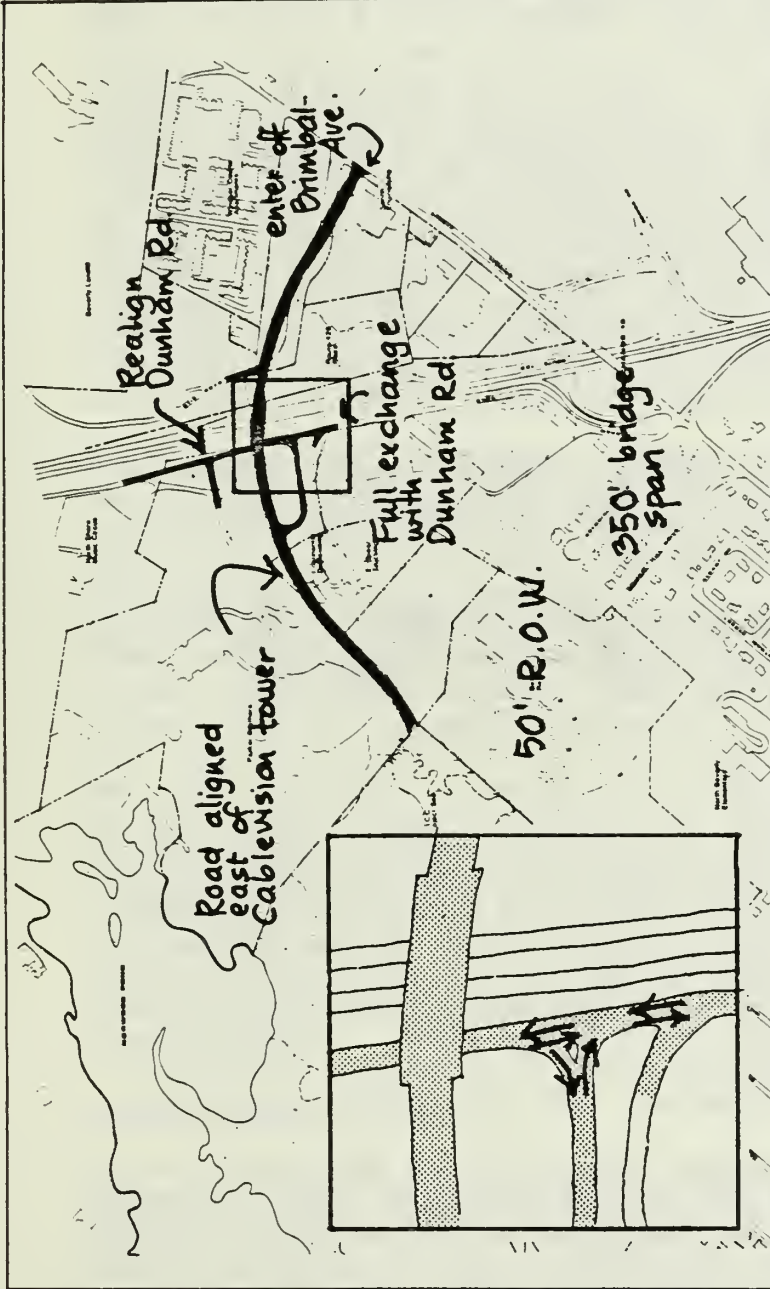


Figure 7 ACCESS ROAD OPTION III

**NORTH SHORE COMMUNITY COLLEGE  
AND ACCESS ROAD EIR/EA**

Norwood Pond Campus

Massachusetts Division of  
Capital Planning and  
Operations  
source: Mass DPW,  
Anderson-Nichols, 1983  
no scale

Anderson-Nichols  
& Co., Inc. 1983



North Shore Community Col-  
lege Traffic-Impact Study

Technical Report 50  
November 1985

ACCESS-ROAD OPTION III

**CTPS**

**FIGURE**  
1-5

crossing over Route 128 and meeting the southern corner of the NSCC site. A 50' right-of-way corridor for this alignment is illustrated in Figure 5.

This option would require a new 300' bridge structure which would cross over Route 128, and the new road would service the proposed college, the easterly portion of Dunham Road, and would provide a feeder drive to the Beverly landfill.

This option includes a dead-ending of Dunham Road at the Beverly/Peabody Times property. All local traffic from the easterly portion of Dunham Road including Parker Brothers, E. Spear Trucking, the North Shore Music Circus, Montserrat School of Visual Arts and the North Shore Grinding Company, would utilize the new NSCC road as their access route. A ramp parallel to Route 128 would provide the connection to the access road. The dead-ending of Dunham Road would allow a shorter length of bridge decking over Route 128.

Under Option I, the roadway alignment from Route 128 to the NSCC site would run west of the Continental Cablevision television tower and avoid the existing Parker Brothers parking lot.

Estimated construction cost including all roadway, bridge, ramp and local road construction is \$2,350,000. Estimated right-of-way costs are an additional \$270,000.

#### Access Road Option II

Access Road Option II follows the same general alignment as Option I along Otis Road (Beverly landfill road). Once over Route 128, the Option II alignment would follow a course slightly east of the Option I alignment resulting in a centerline running directly through the Continental Cablevision television tower, then connecting with the college site. In order to cross over both Route 128 and Dunham Road a longer bridge deck (approximately 350') would be required.

Under Option II, Dunham Road would be maintained as a two-way road up to the Beverly/Peabody Times entrance. East of this point Dunham Road access would be maintained in a one-way direction (east). Exiting traffic from the easterly portion of Dunham Road will be directed on a loop connecting the new access road which then connects to Brimbal Avenue. Dunham Road will be realigned so as to prohibit its use as an access route to the NSCC site.

Total length for Option II is approximately 2,800 feet. estimated construction costs are \$2,600,000 and estimated right-of-way costs total \$370,000. In addition to roadway construction and right-of-way costs, the Option II alignment with its centerline placed directly through the current location of the Continental Cablevision television tower, may have added costs associated with the relocation of this facility. These added costs are speculative in nature, as is the future disposition of the tower structure itself. Completely independent of the NSCC college project, Parker Brothers during the fall of 1982, initiated litigation against the City of Beverly and Continental Cablevision seeking removal of the television tower for alleged violation of zoning and building code requirements. In December, 1982, the Massachusetts Superior Court ruled in favor of Parker Brothers citing that the building permit for the tower is "null and void" (the implication being that the tower will have to be removed and relocated).

Subsequent to this action, Continental received a Stay Motion pending appeal of the decision to the Massachusetts Appeals Court. Affidavits filed by Continental for the Stay Motion state estimated costs associated with relocation of the facility ranging from \$400,000 to \$5,000,000. The low figure estimating costs associated with relocating the physical structure (tower, satellite dishes, communications), while the higher figure includes estimates of lost revenues if the system were shut down for seven months during the relocation effort. As of this writing, the appeal is to be heard in approximately six months. It is most likely that this issue will be resolved prior to preliminary engineering and design of the access road. If these issues are not resolved, and/or the tower is allowed to remain in its present location, the added cost of removal and relocation would have to be incorporated into the project development costs for the access road.

#### Access Road Option III

This option would accommodate a full traffic exchange between Dunham Road and the proposed new access road from Brimbal Avenue. In order to accommodate this interchange the placement of the access centerline would lie further east than under Options I and II. Dunham Road would be straightened to parallel Route 128, and a new bridge would be required to span both Route 128 and Dunham Road as under Option II. North of Route 128 the alignment centerline would pass east of the Continental Cablevision television tower. This

would necessitate some modification of guy wires supporting the tower. Traffic to the college or upper Dunham Road could utilize either the new access road or the old Dunham Road.

Estimated construction costs are \$2,550,000 and estimated right-of-way costs total \$370,000 exclusive of costs to relocate all or part of the Continental Cablevision tower facilities.<sup>1</sup>

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<sup>1</sup>Ibid.

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## 2 TRAVEL ANALYSIS

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### 2.1 OVERVIEW OF ANALYSIS METHOD

The traffic analysis focused on identifying base year traffic conditions and then comparing these conditions to the forecast year with and without the college in operation. In identifying forecast-year conditions, the growth in traffic which will occur naturally and that which will occur through new local growth were also considered. The comparison between base- and forecast-year conditions was made through a review of congestion levels (volume/capacity ratios) at intersections in the immediate area. The traffic analysis included analysis of Dunham Road, the new access road, Brimbal Avenue, and connections between Brimbal Avenue and Route 128.

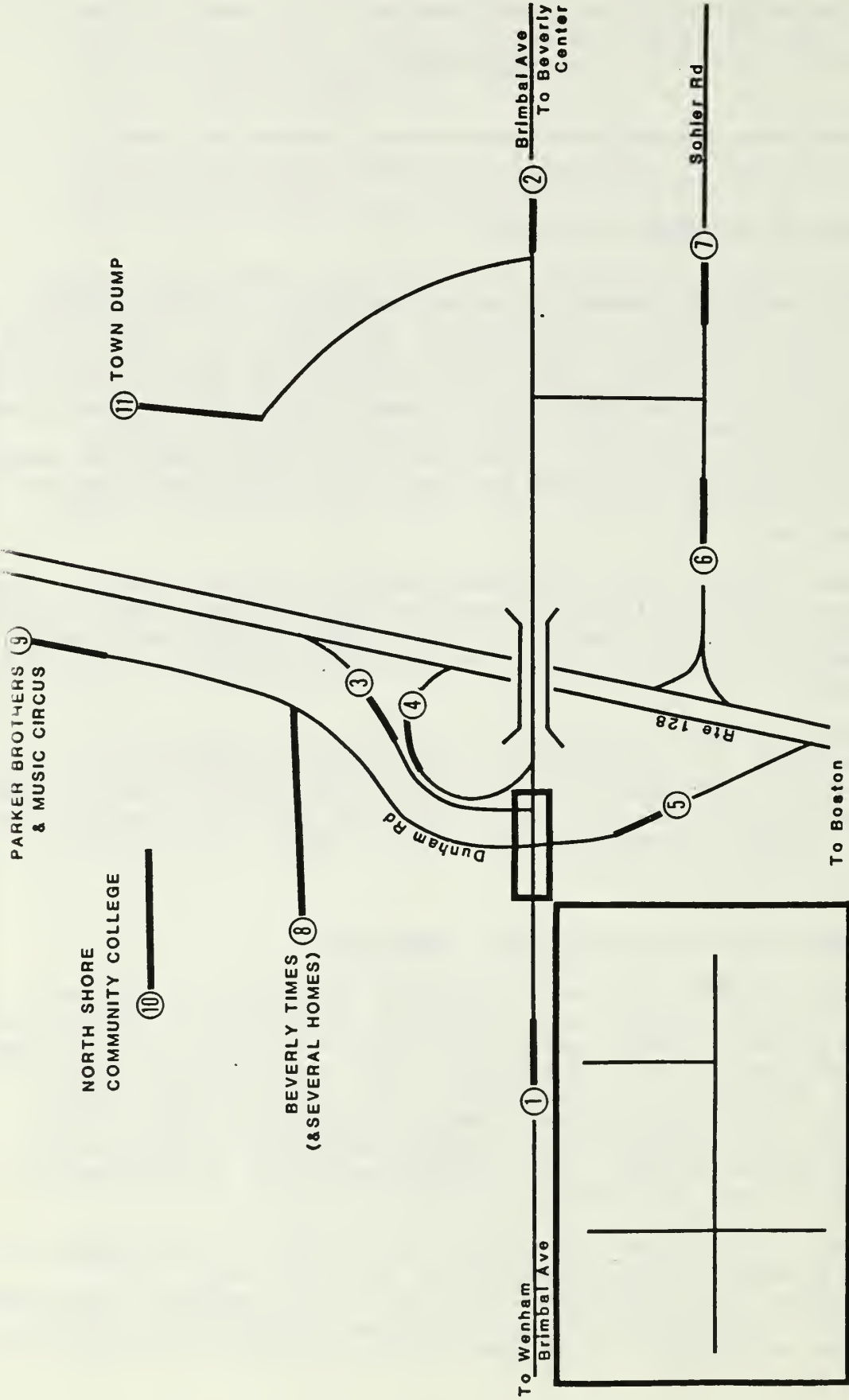
A base year of 1982 and a forecast year of 1987 were used. These years were selected since the vehicle turning movements taken by the Massachusetts Department of Public Works (MDPW) were taken in 1982, and since 1987 was the original projected opening date for the college.

Since standard traffic-congestion analysis is conducted for hourly periods, the analysis for this study was done for an AM peak hour and a PM peak hour--the two major traffic-flow periods. The AM peak represents the major flow when traffic is accessing the area (people coming into the area to work). The PM peak represents traffic exiting.

### 2.2 IDENTIFICATION OF BASE-YEAR CONDITIONS

The initial step undertaken to identify base-year conditions involved the development of a schematic of the area. This schematic served as a common base map on which base- and future-year traffic volumes could be presented. The schematic was also needed to facilitate the development of a trip-exchange table. Creating a trip table for the area was important since it not only aided the development of turning movements from traffic generated by the college, but enhanced accuracy in forecasting traffic increases from natural and local growth.

The schematic developed (see Figure 2-1) shows a zone number at each point where a major road leaves the study area. For example, Zone 1 is illustrated with a "1" in a circle. This zone will serve to represent, in a trip table, all vehicles which enter from (originate in) or leave (are destined) for areas



**CTPS**

**FIGURE**  
2-1

EXISTING NETWORK

**NOT TO SCALE**

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served by Brimbal Avenue north of Route 128. Similarly, zone numbers 2, 6, and 7 represent trips which originate in or are destined for areas served by the roads to which they refer. Zones 3, 4, and 5 have the same function as Zones 1, 2, 6, and 7; however, the roads which they represent are one-way and therefore have only origins or destinations. Zones 8, 9, 10, and 11 define specific subareas within the study area. For example, Zone 9 represents all trips which are destined for or originate from either Parker Brothers or businesses east of Parker Brothers on Dunham Road.

The next task involved the identification of the base-year turning movements to be used in the analysis. The MDPW collected turning movement data at the Route 128/Brimbal Avenue interchange in 1982. The DPW then adjusted these counts to represent average conditions. Figure 2-2 depicts these turning movements for an average weekday. Based on the data collected, the MDPW then determined that the morning peak hour was 7:00-8:00 AM and the afternoon peak was 4:00-5:00 PM.

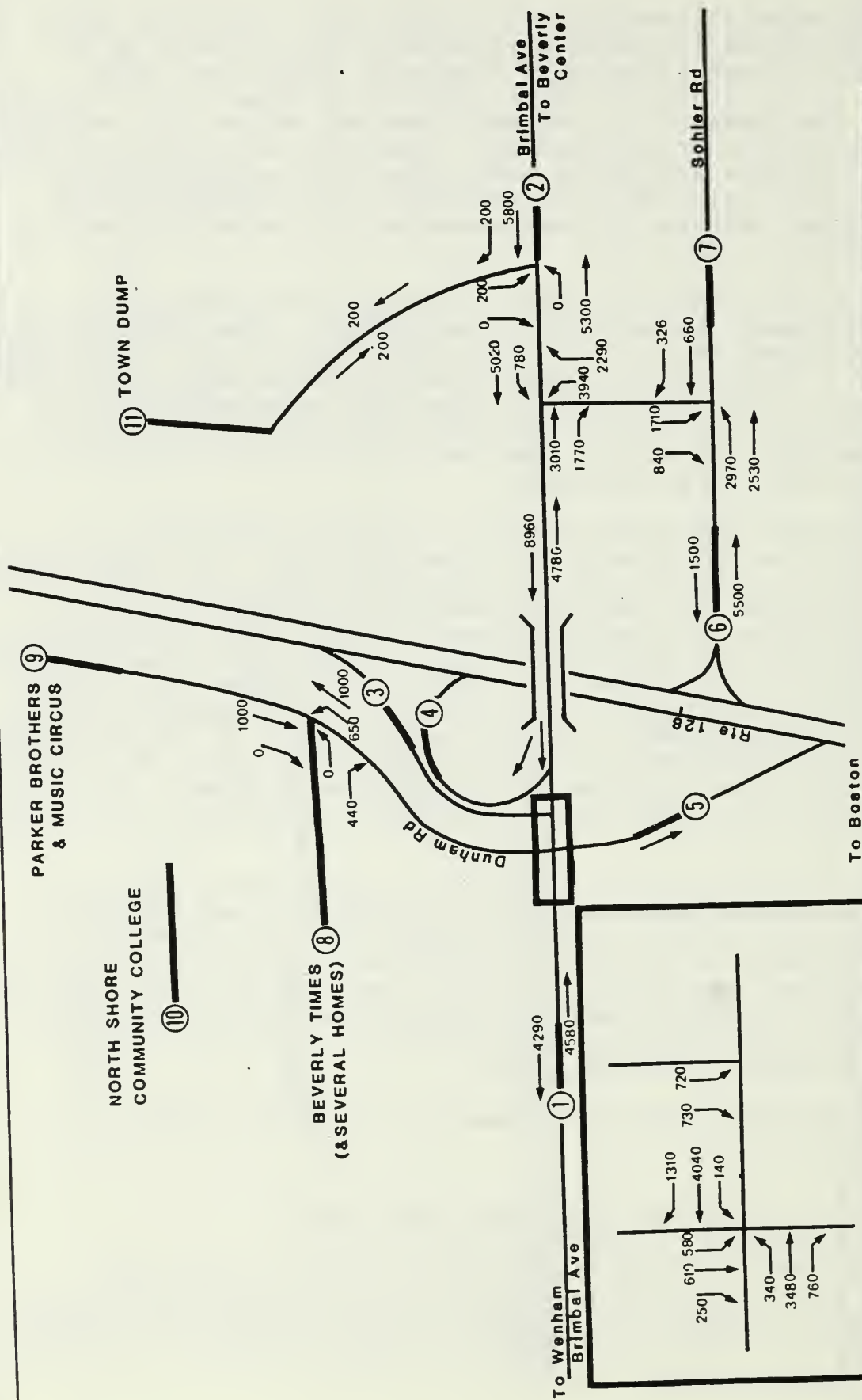
A trip-exchange table was prepared, using the zones shown in Figure 2-2. As can be seen by reviewing Figure 2-2, many of the trips between zones are readily determined from the turning movements. For example, the trips between Zones 6 and 7 are obviously defined by the turning movements at the Route 128/Sohier Road intersection. Similarly, trips between Zones 1 and 5 can be readily identified. There are also trip exchanges which logically should not be made. For example, trips between the Route 128 northbound off-ramp at Sohier Road (Zone 6) to the Route 128 southbound on-ramp (Zone 5) were assumed to be zero. It was also assumed that there would be zero trips between Zones 3 and 4, meaning no vehicle would get off Route 128 southbound to get back on again.

To augment the trip-table-development process, CTPS obtained information with regard to town of residence of Parker Brothers employees from John G. Crowe Associates, Inc., consultants to Parker Brothers. From the MDPW, CTPS received information on the traffic volumes generated by several area businesses and the town dump. After exhausting all possible sources for establishing trip-exchange information, CTPS estimated exchanges based on turning movements where necessary.

The trip-exchange table developed for the average weekday is shown in Table 2-1.

### 2.3 IDENTIFICATION OF FUTURE-YEAR CONDITIONS

The first step in the identification of future conditions involved updating of the schematic in Figure 2-1. As discussed in chapter 1, access to the college would be provided by one of three possible access-road options. Shown in Figures 2-3 through



CTPS

FIGURE

2-2

EXISTING NETWORK  
BASE YEAR  
1982 AVERAGE DAILY TRAFFIC

NOT TO SCALE

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DESTINATION ZONES

	1	2	3	4	5	6	7	8	9	10	11	Total
1	--	181	--	0	151	13	110	19	5	0	0	479
2	142	--	--	293	9	17	41	15	10	0	10	537
3	33	55	--	0	0	0	111	2	5	0	0	206
4	--	--	--	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--	--	--	--	--
6	6	123	--	0	0	--	436	3	45	0	0	613
7	4	41	--	107	6	20	--	0	10	0	0	191
8	3	1	--	0	14	1	0	--	0	0	0	19
9	5	5	--	0	5	5	5	0	--	0	0	25
10	0	0	--	0	0	0	0	0	0	--	0	0
11	0	10	--	0	0	0	0	0	0	0	--	10
Total	193	416	--	400	185	56	703	42	75	0	10	

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TRIP-EXCHANGE TABLE  
EXISTING NETWORK  
EXISTING LAND USE  
1982 - 7:00-8:00 AM

**CTPS**

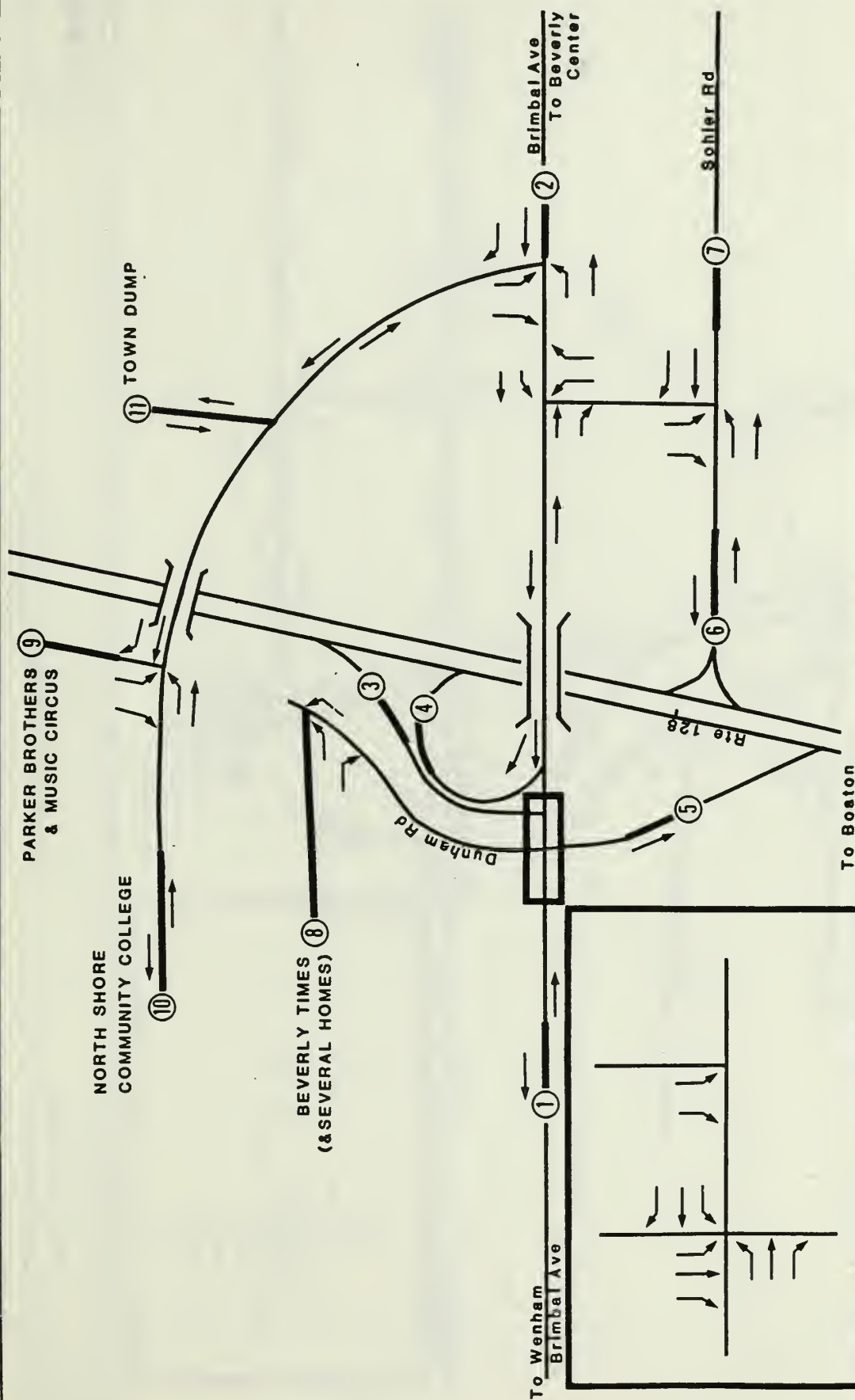
TABLE  
2-1

2-5 are the schematics developed to represent the three access options. Note on each of these figures the turning movements allowed between Dunham Road and the new access road. The ability or inability to make a maneuver at this intersection impacts turning movements throughout the study area.

The next step associated with identifying future traffic volumes was the identification of traffic growth likely to result from population and employment changes projected to occur in the town of Beverly and the region in general. Growth was estimated for each of the zones depicted on the area schematic. Zone 11 is the town dump; in conversations with Beverly town officials, the MDPW has indicated that the traffic entering and leaving the dump totaled 400 vehicles per day in 1982. The MDPW has indicated that this will remain constant. For Zones 8, 9, and 10, growth in traffic is associated with how various parcels of land are developed. Zone 10 is the site of the new college; Zone 9 is Parker Brothers, the Music Circus, and other businesses on the eastern end of Dunham Road; Zone 8 is all of Dunham Road south of Parker Brothers. Growth in these areas was estimated separately. For Zones 2 and 7, the growth in traffic was determined to be most strongly related to growth within the town of Beverly. For Zone 1, traffic growth was determined to be related to the growth of both Beverly and Wenham. Growth in Zones 3-6 was determined to be related to growth on the entire North Shore. To forecast traffic growth, the procedure presented in Quick Response Urban Travel Estimation Techniques and Transferable Parameters (Transportation Research Board Special Report 187, 1978) was used.

Using equations presented in this report, the total number of trips generated on an average weekday could be estimated by community and time of day, based on population and employment. A traffic-growth rate was then estimated by calculating the total trips produced by an area for 1982 and comparing them to the total trips produced by the same area for the forecast year. The ratio of forecast/base year defined the growth rate, which was then applied to traffic volumes. For example, for Zones 2 and 7, the growth in traffic was determined based on changes in total trips generated in the town of Beverly. Since the technique identifies growth by time of day, each of the three trip tables (AM peak, PM peak, average daily) could be projected to 1987.

In order to apply this forecasting technique, employment and population projections are required. These forecasts were acquired from the Metropolitan Area Planning Council and are summarized in Table 2-2. The forecast year for the analysis was 1987. This reflects when the college was expected to open. In order to determine growth in traffic from 1982 to 1987, the population and employment figures had to be interpolated (since they are in five-year increments). It has since been determined that the opening date for the college will most likely be in 1988. All of the analysis was performed for 1987. This does not appear to be a problem, since the growth in traffic has been estimated



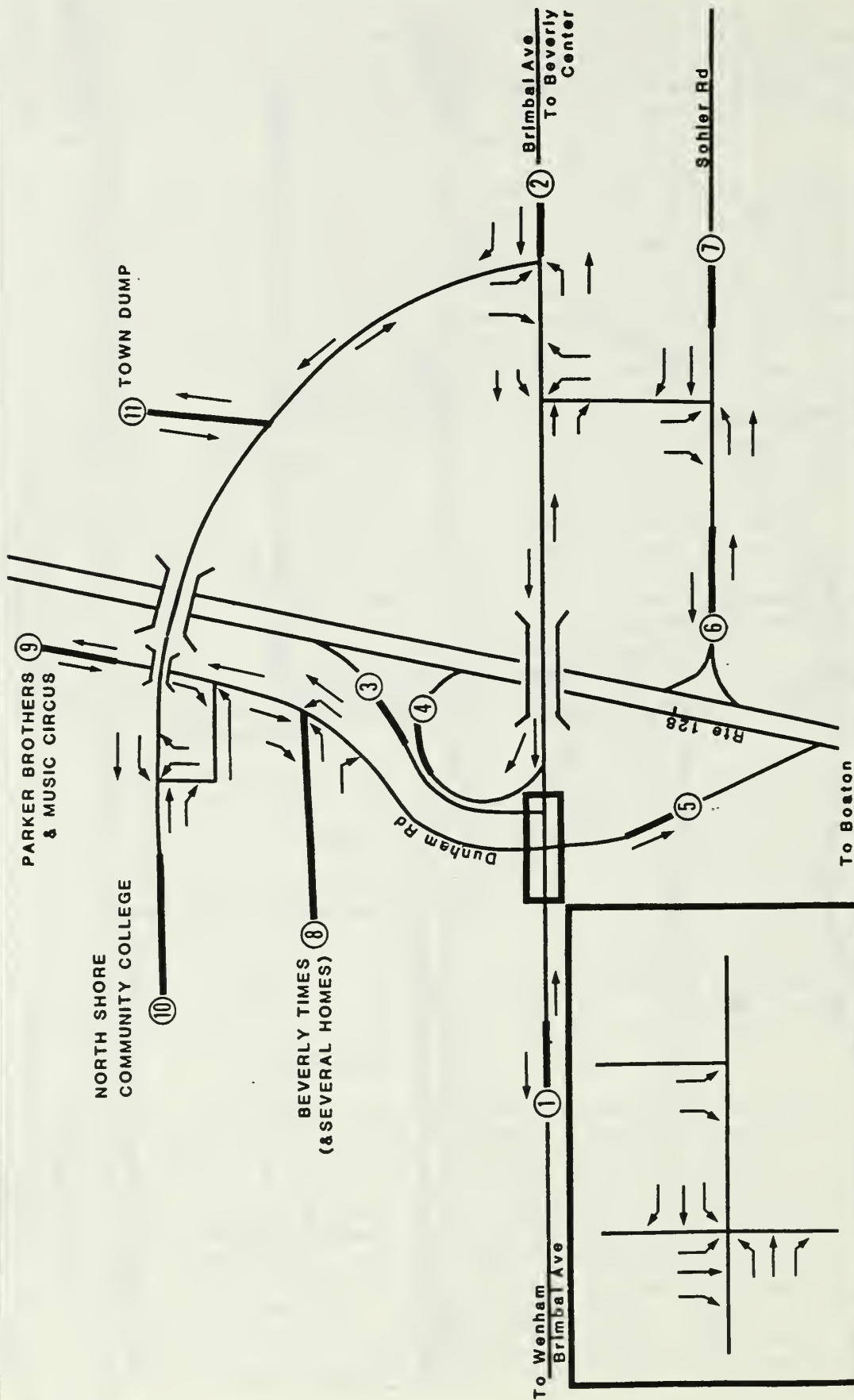
# STC

FIGURE  
2-3

## ACCESS OPTION I SCHEMATIC

**NOT TO SCALE**

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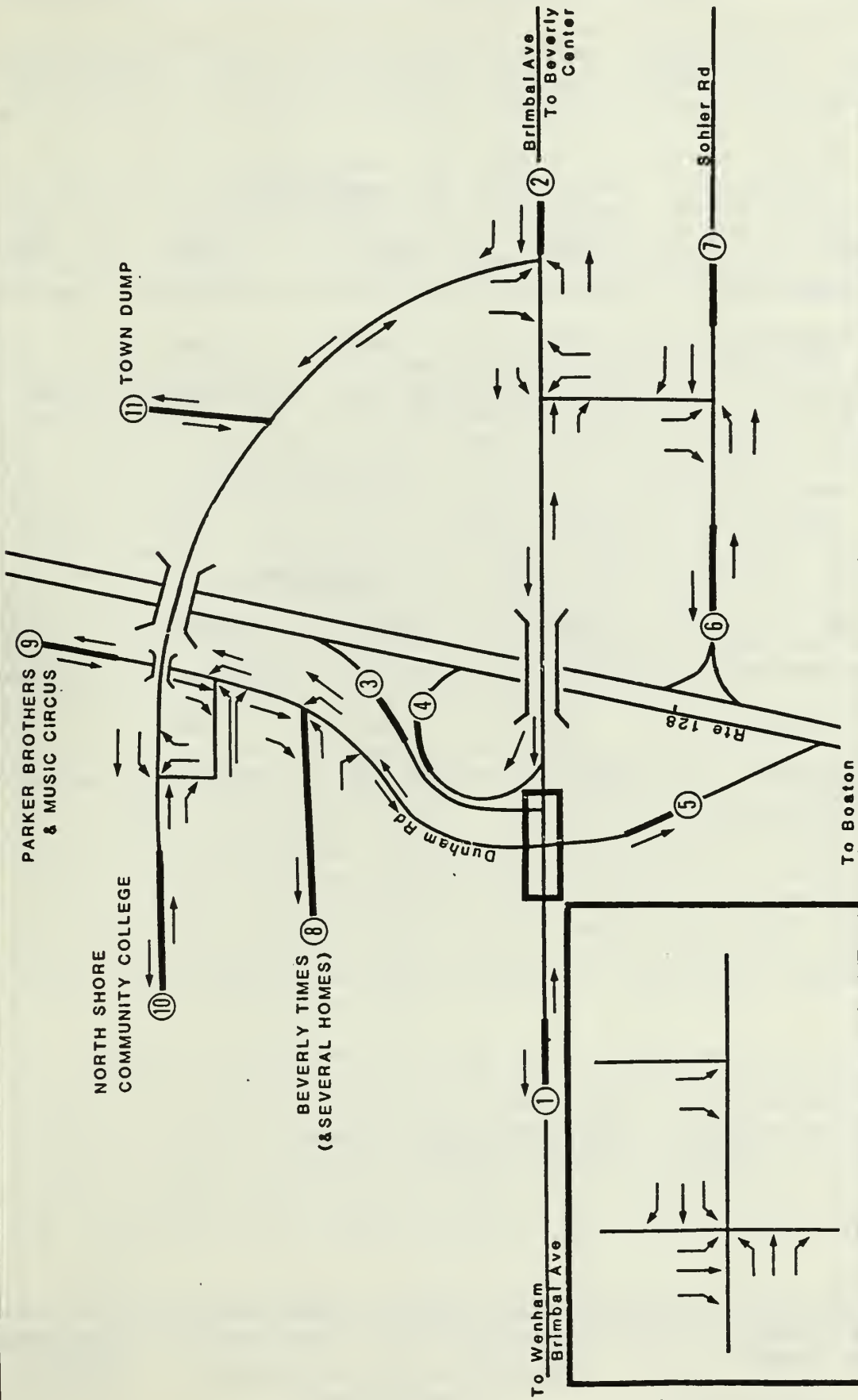
CTPS

FIGURE  
2-4

ACCESS OPTION II  
SCHEMATIC

NOT TO SCALE

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	<p><b>NOT TO SCALE</b></p>	<p>ACCESS OPTION III SCHEMATIC</p>	<p><b>CTPS</b></p>
<p>Technical Report 50 November 1985</p>	<p>FIGURE 2-5</p>		

<u>Area</u>	<u>Population</u>			
	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>2005</u>
Town of Beverly	37,655	37,700	37,700	37,700
Town of Wenham	3,897	3,900	3,900	3,900
North Shore	449,238	447,700	446,300	445,700

<u>Area</u>	<u>Employment</u>			
	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>2005</u>
Town of Beverly	12,675	13,200	13,500	13,800
Town of Wenham	498	500	550	550
North Shore	175,938	180,800	184,200	188,100

Source: Metropolitan Area Planning Council

NSCC Traffic- Impact Study	POPULATION AND EMPLOYMENT PROJECTIONS	<b>CTPS</b>
Technical Report 50 November 1985		TABLE 2-2

to be very small. A delay of one or two years will not have a significant impact on the traffic-growth projections. Table 2-3 indicates the growth in traffic volumes estimated to occur for each zone in the periods 1982-87, 1982-2005, and 1987-88.

The above projections identified growth in areas outside the study area which influence the study area. Projections were next made of growth within the study area. As of this writing, there are only two major projects known to be under consideration for construction in the study area. The first is the new college, and the second the expansion of Parker Brothers.

As of 1982, Parker Brothers had 413 employees at its Beverly, Dunham Road facility. Parker Brothers anticipates that a 50,000-square-foot expansion will be operational by the fall of 1985. Sometime before the year 2005, Parker Brothers plans a second expansion to bring its Dunham Road complex to 250,000 square feet. Using Trip Generation (Institute of Transportation Engineers, 1979), the number of trips entering and leaving the Parker Brothers site (for AM peak, PM peak, and average daily) was estimated. In 1982, the average daily traffic (ADT) entering and leaving the Parker Brothers area (which includes all other businesses east of the Beverly Times) was 1,000. By 1987, this figure would reach 2,680, and by 2005 it would be 3,720. Town-of-residence information for Parker Brothers employees was available for 1980; it was assumed that future employees will have proportionately the same towns of residence.

CTPS was provided information which put the total day-division student enrollment of all of the campuses to be combined in the new college at 2,082 students. Using the ITE Trip Generation manual referenced earlier, this enrollment was estimated to generate 1,613 vehicle trips entering the site in a day, and 1,613 leaving. The evening-division enrollment of approximately 1,500 students will generate an additional 1,162 vehicle trips entering and 1,162 leaving. In all, approximately 2,775 vehicles will enter the site and 2,775 will leave. The total traffic volume generated by the new college is, therefore, approximately 5,550 vehicle trips per day.

The information provided to CTPS also indicated the enrollment by time of day. These figures show that approximately 1,312 students will enter the site for classes that begin between 8:00 and 9:45 AM, with at least 748 students having classes which start between 8:00 and 8:50 AM. Based on these figures, it was estimated that 797 vehicles will enter the site and 84 will exit during the 7:00-8:00 AM peak hour. The PM peak hour (4:00-5:00 PM) volume has also been estimated and is 267 exiting and 107 entering.

Also indicated in the enrollment information is the enrollment by community of residence. Utilizing this information, the point of access to the analysis area, and thus to the college, was deter-

Traffic- Growth Period	Zones		
	<u>1</u> <u>Beverly/ Wenham</u>	<u>2,7</u> <u>Beverly</u>	<u>3-6</u> <u>North Shore</u>
1982-87			
AM Peak Hour	3.0%	3.1%	1.8%
PM Peak Hour	2.0	2.6	1.1
ADT	1.9	2.2	1.1
1982-2005			
AM Peak Hour	6.5%	6.6%	5.2%
PM Peak Hour	4.2	5.3	4.4
ADT	3.9	4.6	3.6
1987-88			
AM Peak Hour	0.2%	0.2%	0.2%
PM Peak Hour	0.1	0.2	0.2
ADT	0.1	0.2	0.1

NOTE: These figures represent the gross percentage increase during each period of years shown.

NSCC Traffic- Impact Study	TRAFFIC-VOLUME GROWTH	<b>CTPS</b>
Technical Report 50 November 1985		TABLE 2-3

mined. Figure 2-6 shows the traffic volumes generated by the college for an average weekday.

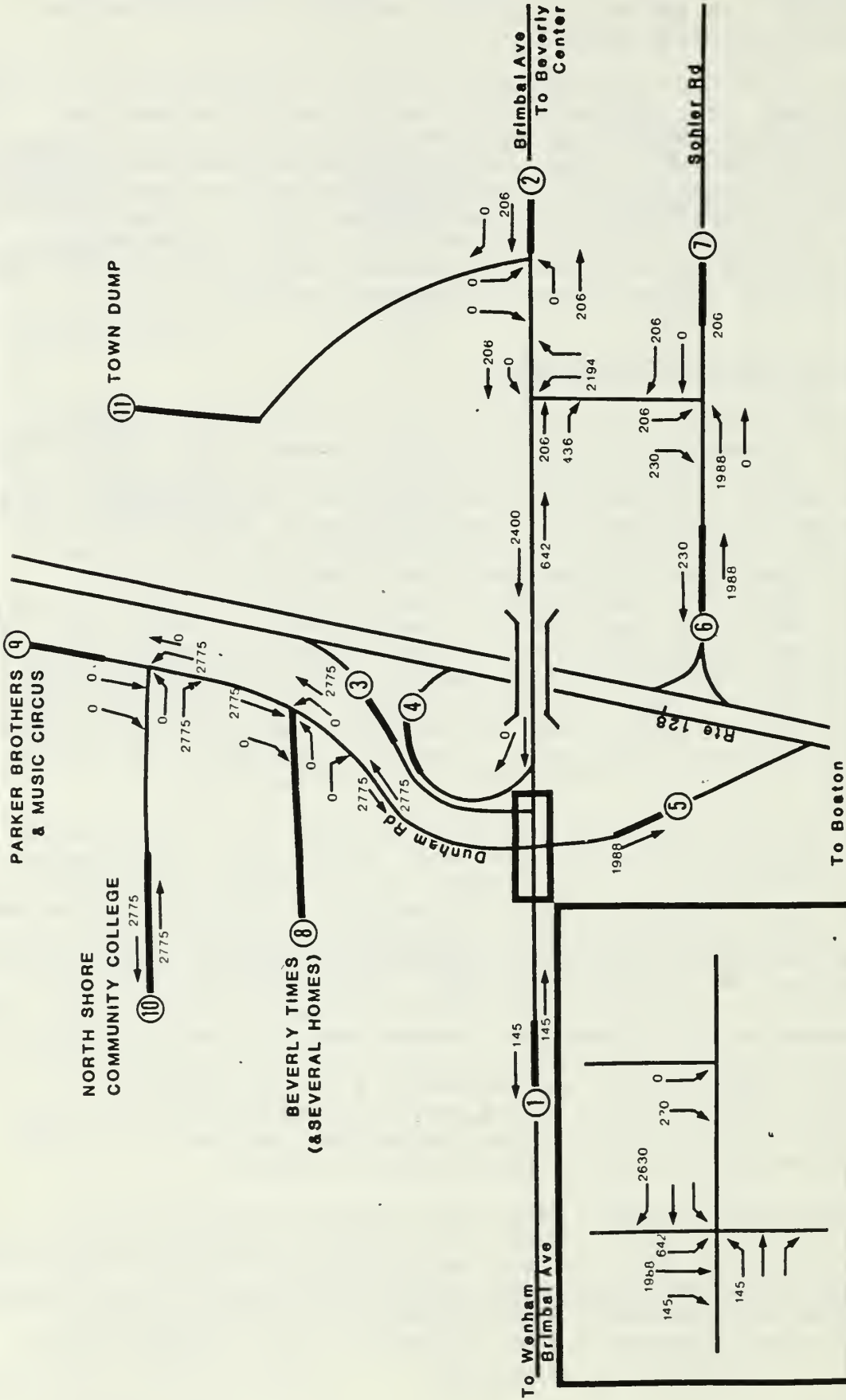
Combining all of the trip-generation data discussed above allowed the development of a series of trip tables which reflect the volume of traffic which will enter the study area at the various study-area boundaries. These trip tables were then used to develop traffic volumes for each access-road option for each of three time periods (AM peak, PM peak and average daily). Shown in Figures 2-7 through 2-10 are the average daily traffic volumes estimated for 1987 without the new college, and for 1987 with the college and each of the three site-access options.

## 2.4 TRAFFIC-ANALYSIS TECHNIQUES

As mentioned earlier, the analysis for this study was based on the change in congestion levels likely to occur after the college is opened. In an urban area, the capacity of arterial and collector streets is controlled primarily by intersections. This is the case in Beverly along Brimbal Avenue at Route 128. Unsignalized intersections in close proximity to one another, with large numbers of turning vehicles, constrain the area's capacity. Therefore the analysis focused on establishing congestion levels for each of two time periods (AM peak hour, PM peak hour) both for a base year and for a forecast year with the various access-road options. To aid in understanding how each access-road option affects traffic patterns, one additional scenario was also analyzed. This scenario was to build the college without building an access road. For this scenario the college was assumed to access Brimbal Avenue via Dunham Road.

At all of the intersections in the study area, the minor street flow is stop-sign-controlled and major street flow is unimpeded. At most intersections, each movement on the minor street has its own lane. For example, at the intersection of Brimbal Avenue and the Route 128 northbound/Sohier Road off-ramp, right turns to Brimbal Avenue southbound have a separate lane from left turns to Brimbal Avenue northbound. The only intersection where this is not the case is the Brimbal Avenue/Dunham Road intersection. All of the movements which come from Dunham Road must share one lane. These lane-utilization factors are taken into consideration in the capacity calculations (see Appendix A for intersection geometrics). This is why, in subsequent sections of this report service levels will be listed for individual movements at some intersections and for entire approaches at others.

The technique used in this study to calculate congestion at unsignalized intersections came from Interim Materials on Highway Capacity, (Circular 212, Transportation Research Board, 1980), pages 37-40). In this technique, only intersections which have uncontrolled major-street flows and stop- or yield-sign-controlled minor streets can be analyzed. The technique allows



CTPS

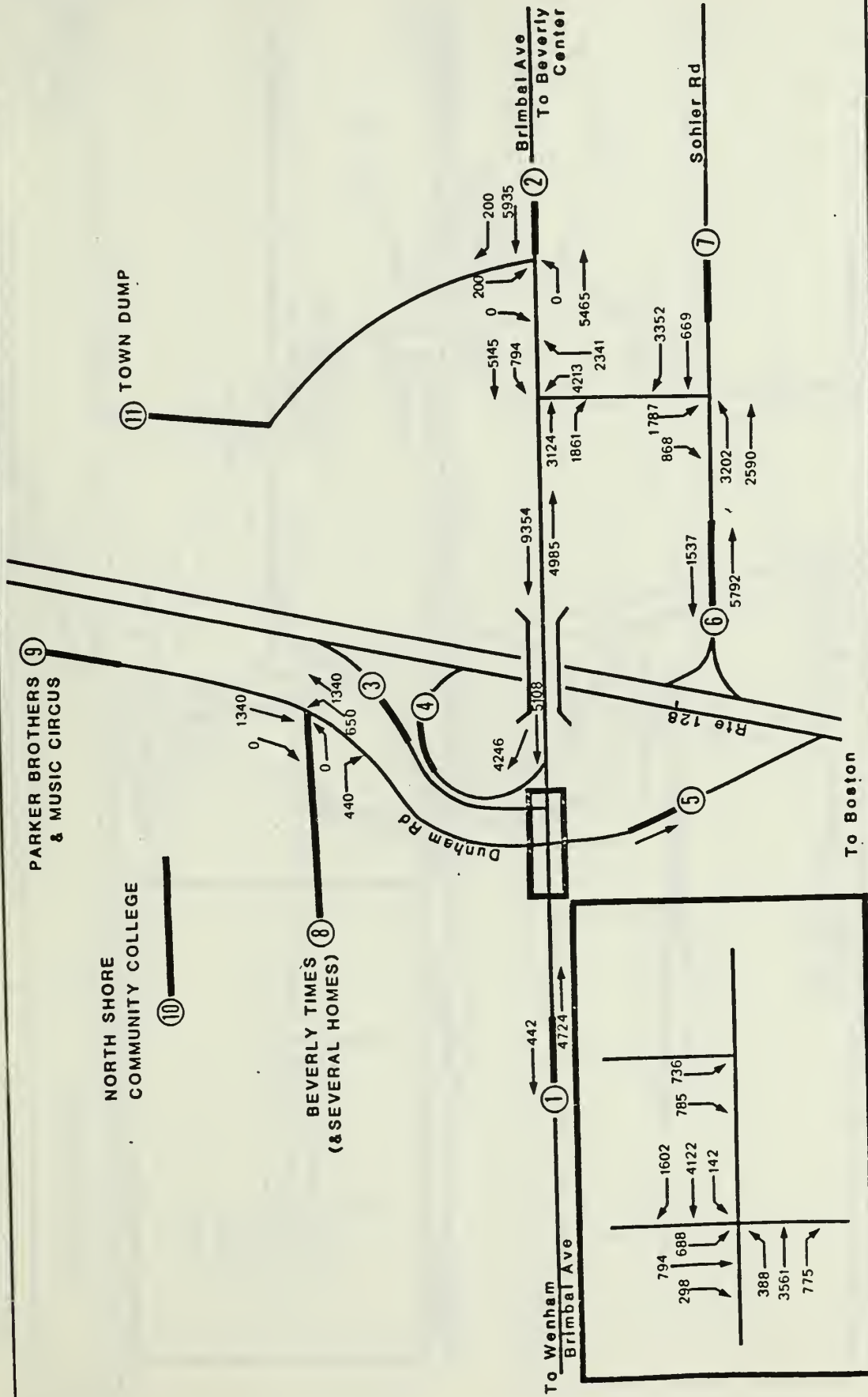
FIGURE

2-6

PROJECTED VEHICLE-TRIPS GENERATED BY COLLEGE  
(AVERAGE DAILY TRAFFIC)

NOT TO SCALE

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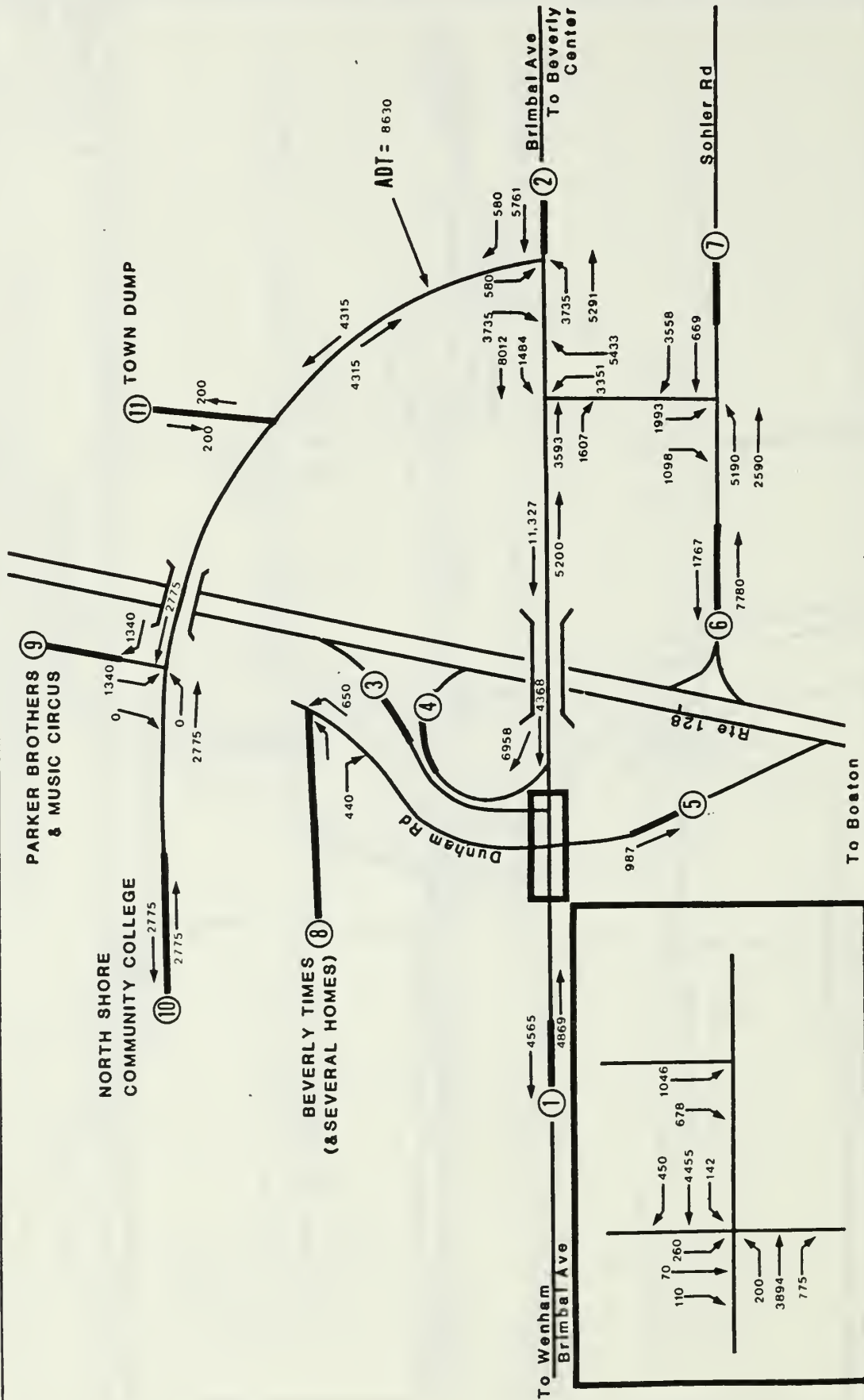
CTPS

FIGURE  
2-7

EXISTING NETWORK  
WITHOUT COLLEGE/  
WITH 50,000-SQ.-FT. PARKER BROTHERS EXPANSION  
1987 AVERAGE DAILY TRAFFIC

NOT TO SCALE

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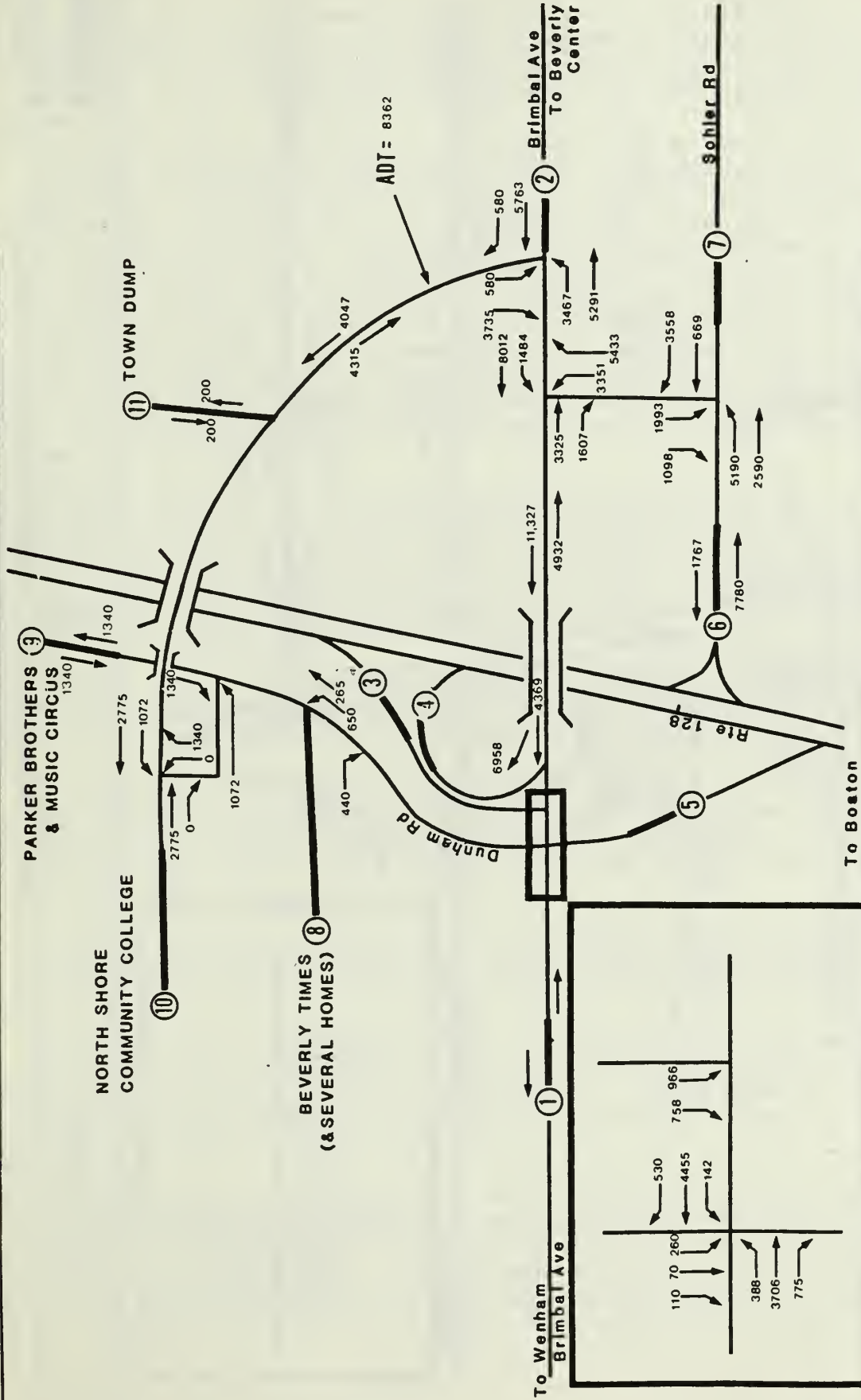
CTPS

FIGURE  
2-8

OPTION I  
WITH COLLEGE/  
WITH 50,000-SQ.-FT. PARKER BROTHERS EXPANSION  
1987 AVERAGE DAILY TRAFFIC

NOT TO SCALE

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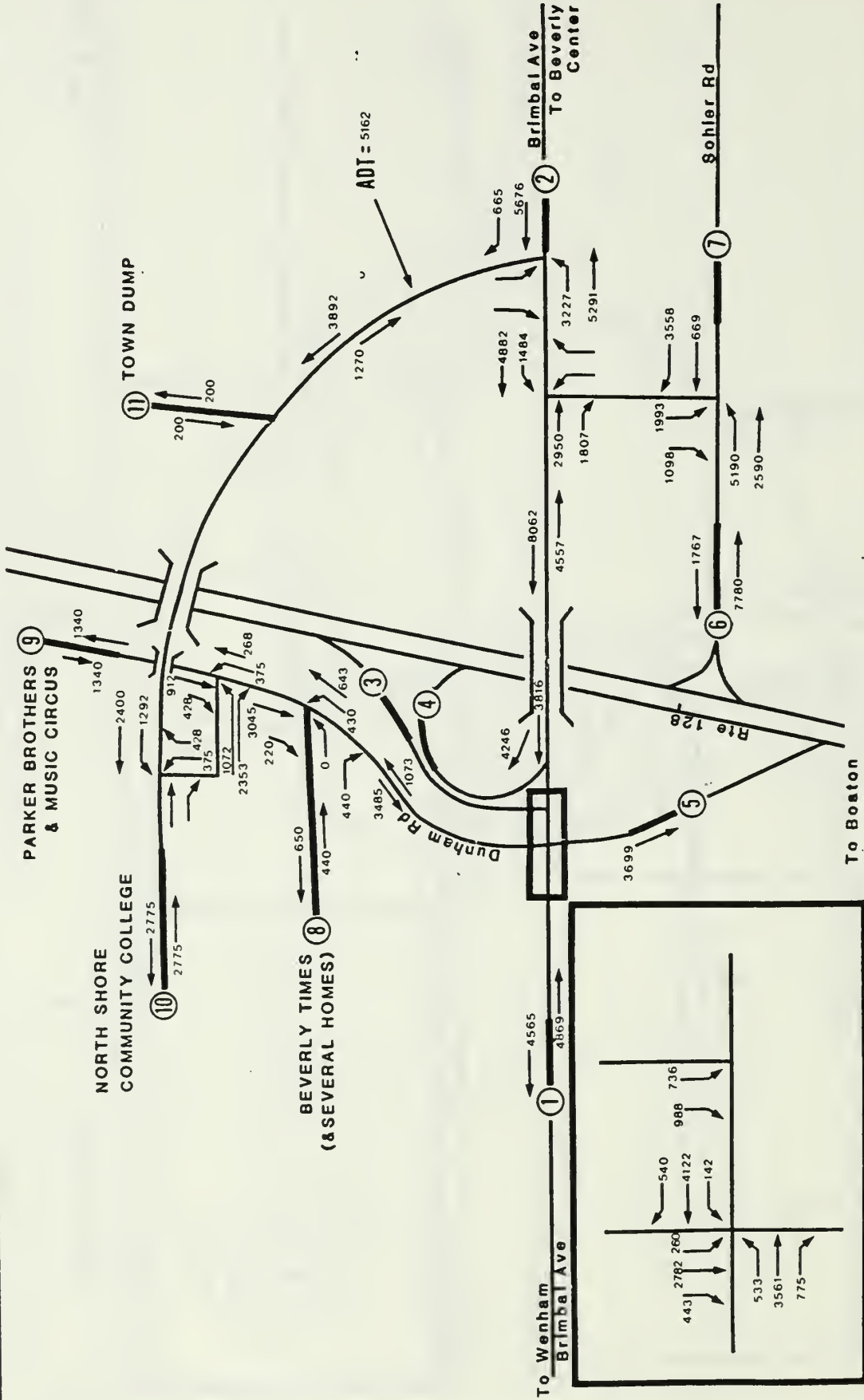
CTPS

FIGURE  
2-9

OPTION II  
WITH COLLEGE/  
WITH 50,000-SQ.-FT. PARKER BROTHERS EXPANSION  
1987 AVERAGE DAILY TRAFFIC

NOT TO SCALE

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CTPS

FIGURE  
2-10

OPTION III  
WITH COLLEGE/  
WITH 50,000-SQ.-FT. PARKER BROTHERS EXPANSION  
1987 AVERAGE DAILY TRAFFIC

NOT TO SCALE

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service levels (congestion levels) to be calculated for major street left turns to the minor street and for all minor-street movements. Major-street through movements and right turns are assumed to be unimpeded and therefore do not require analysis.

The technique calculates the intersection's ability to handle traffic in terms of the average gap in opposing traffic into which the cross-street traffic will be required to merge. The frequency of occurrence of acceptable gaps is then translated into service level. In general, the average driver will wait for a gap in opposing traffic of at least 6.2 seconds before he will attempt to traverse the traffic flows with a left-turn maneuver. Through traffic will seek a gap of at least 5.8 seconds, and right-turn traffic 5.4 seconds. Left turns are by far the most difficult maneuver: a large gap is generally needed for crossing several traffic flows. A discussion of each of the six service levels and the relationship between service level and average vehicle delay follows.

Service level A is the best operating condition. If a movement at an intersection is at service level A, it means that after the vehicle stops at the stop sign an acceptable gap for its maneuver will occur in traffic almost immediately. Except for the delay caused by the stop sign, there are no delays encountered by vehicles making the maneuver being analyzed.

Service level B is almost as good a situation as service level A. On the average, most vehicles will have delays of 10-15 seconds before an acceptable gap in traffic occurs.

Service level C is in most cases the minimum service level that a new design should provide. However (it should be noted), movements at this level are not considered deficient. The average vehicle may wait 15-19 seconds before an acceptable gap in traffic occurs.

Service level D indicates that a movement is nearing failure. Average vehicle delay (stopping time plus time waiting in queue, if any, plus time waiting for acceptable gap) is 19-35 seconds.

Service level E indicates that the location is no longer operating at a safe level and consideration should be given to the installation of signal equipment. A maneuver at this service level is characterized by extensive queuing. Average total vehicle delay is 35-60 seconds.

Service level F is the worst service level, and indicates that no acceptable gaps occur during the period of analysis (usually an hour). If a maneuver is operating at this level, it means that the traffic is moving into unacceptable gaps of 3-5 seconds (or less). This situation is well beyond an acceptable level of service and, like service level E, is unsafe.

The relationship of vehicle delay to service level is summarized below:<sup>1</sup>

<u>Service Level</u>	<u>Expected Average Total Vehicle Delay</u>
A	0-10 seconds
B	10-15 "
C	15-19 "
D	19-35 "
E	35+ "
F	unpredictable

Service levels were calculated for all approaches and movements in each scenario. In conducting the service-level analysis, there were a very large number of analysis forms filled out.

The geometrics of any new intersection were assumed to be one travel lane approaching the intersection, with the intersection wide enough to allow through and right turns to move without being impeded by left turns.

Rather than simply assuming that the relationships of service level and average vehicle delay that are expected to occur in theory are correct, CTPS staff measured actual delay at study-area locations on January 18, 1984. between 7:00 and 8:30 AM. These observations were made at the two intersections with the worst service levels in the AM peak period. These locations are:

- Brimbal Avenue at the Sohier Road ramp
- Sohier Road at Sohier Road ramp/Route 128

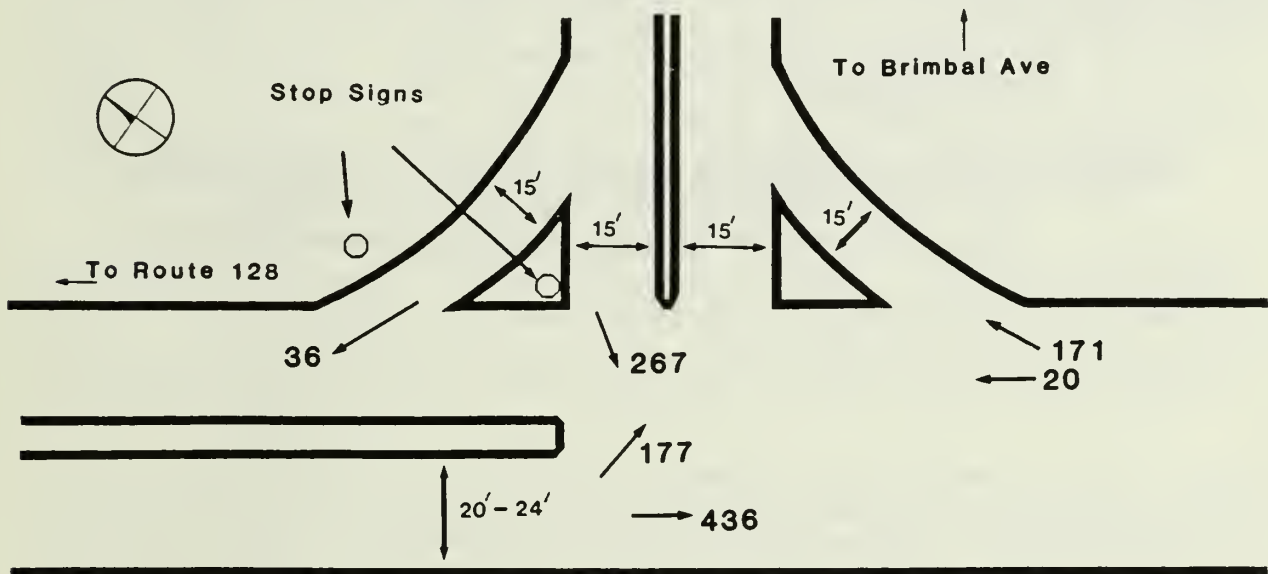
Service-level analysis showed that left turns from the Sohier Road ramp to Brimbal Avenue northbound were at service level E in the AM peak hour. This would indicate that the average vehicle delay should be greater than 35 seconds. Based on the sampling of 100 vehicles, the average delay was found to be 45.5 seconds. For right turns from the Sohier Road ramp to Brimbal Avenue southbound, the service level was determined to be A. The expected average delay is 0-10 seconds. Based on a sampling of 50 vehicles, the average delay was observed to be 2.9 seconds.

The survey data at this location demonstrates a close correspondence between the calculated, expected delay and the actual delay, lending credence to the reliability of the analysis technique.

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<sup>1</sup>Institute of Transportation Engineers, Transportation and Traffic Engineering Handbook 1976, p. 355, Figure 8.21.

The service-level analysis shows the intersection of Sohier Road and the ramps from Sohier Road (originally from Brimbal Avenue) to Route 128 to be at service level F. Delays would therefore be unpredictable. The field survey showed that the average delay was 14.4 seconds. This is very different from what was expected from the analysis. There does appear to be an explanation for this. This intersection is the only intersection in the study area where the minor approach supports traffic volumes higher than those on one of the major approaches. The diagram below shows the traffic volumes on each approach.



The minor-street-traffic left turns (even though they are stop-sign-controlled) roll out into the major street through the travel lane, blocking that lane. The minor-street left turns therefore usurp an area of the intersection normally used for major-street through vehicles. Additionally, since the left turns from the minor street begin their maneuver from the middle of the intersection, they appear to be unaffected by the major-street through traffic from Route 128.

The service-level-analysis technique assumes that the minor-street traffic begins its maneuver from the stop line. It also assumes that the volume on the minor approach will be lower than that on either of the major approaches.

It would appear that the service-level analysis is correct at this location, with the problem being more one of safety than one of capacity. There are safety problems at this location which

are the result of traffic edging out into the intersection. Also, the geometrics at this location do not reflect the dominant traffic flow. The service-level analysis points out these problems by putting the intersection in a poor service level. The level of the minor-street traffic volumes is high enough that the left turns have created an acceptable delay for themselves; but, from the safety perspective, this location should be improved.

Average vehicle-queue length refers to the average number of vehicles waiting in line to execute a maneuver. For this calculation, equation 7.141 in the Transportation and Traffic Engineering Handbook (Institute of Transportation Engineers, 1976, page 308) was used. The queue-length equation has been reproduced below.

$$E(n) = \frac{qd}{3,600}$$

where  $E(n)$  = the expected queue length on the approach

$q$  = the flow rate on the approach, = vph

$d$  = average delay per vehicle, seconds/vehicle

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### 3 PROJECTED IMPACTS

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#### 3.1 REVIEW OF BASE-YEAR CONDITIONS

A field reconnaissance of the Route 128/Brimbal Avenue interchange prior to the beginning of the technical analysis for this study noted that this interchange has substandard geometrics. For example, for traffic leaving Dunham Road or leaving the Route 128 southbound off-ramp to Brimbal Avenue, sight distance is below standards. Based on an average travel speed on Brimbal Avenue of 35 mph, side-street traffic should have the ability to see an object  $3\frac{1}{2}$  feet tall a distance of 350 to 400 feet away. This is currently not provided at either of these locations. Side-street sight distance is approximately 275-300 feet.

Another geometric problem occurs at the intersection of Sohier Road with the Route 128 northbound off-ramp. Traffic exiting from Route 128 does not have adequate stopping distance between Route 128 and this intersection. There is no deceleration lane on Route 128, and this intersection is within several hundred feet of Route 128.

Ramps accessing Route 128 have geometric problems as well since many ramps do not provide acceleration lanes. In one case (the Brimbal Avenue northbound on-ramp to Route 128 southbound) traffic has a stop sign at the top of the on-ramp and no acceleration lane on Route 128.

There is not one on- or off-ramp associated with Route 128 at this interchange which comes close to meeting existing geometric standards. This appears to be a problem for many of the Route 128 interchanges in this area.

From a service-level perspective, many of the area's intersections demonstrate capacity problems in both the AM and PM peaks in the base year. Based on the service-level analysis discussed in chapter 2, the following tables (3-1 and 3-2) have been prepared. These tables summarize the service level for each location under each scenario analyzed for both AM and PM peak periods. In the 1982 base year, in the AM peak, capacity problems are primarily associated with the left turns from the minor street to the major street at the following locations:

Sohier Road at Route 128 northbound  
Route 128 southbound at Brimbal Avenue  
Route 128 northbound at Brimbal Avenue

Description	Movement	1982 Base Year	1987					
			No College No Local Growth	No College + Local Growth	With College/With Local Growth			
					Existing Network	Network Option 1	Network Option 11	Network Option 111
Brimbal Ave. at Dunham Rd.	all of Dunham Rd	C	C	C	*F(1.25)	C	C	D
	Brimbal lefts to Dunham	A	A	A	C	A	A	A
	Brimbal lefts to Rte. 128	A	A	A	A	A	A	A
Sohier Rd. at Rte. 128 NB	lefts to Sohier Rd.	*F(1.13)	*F (1.13)	*F (1.26)	*F(9.36)	*F(9.36)	*F (9.36)	*F (9.36)
	rights to Rte. 128	A	A	A	A	A	A	A
	lefts to Brimbal Ave.	A	A	A	B	B	B	B
Rte. 128 SB at Brimbal	lefts from Rte. 128	E	E	E	*F(3.24)	*F(1.28)	*F (1.20)	E
	rights from Rte. 128	A	A	A	E	A	A	A
Rte. 128 NB at Brimbal	lefts to Brimbal	E	E	*F (1.04)	*F(4.76)	E	E	E
	rights to Brimbal	A	A	A	A	*F (1.44)	*F (1.42)	*F (1.23)
	lefts from Brimbal	A	A	A	A	A	A	A
College Rd. at Brimbal	lefts to Brimbal					*F(**)	*F(**)	*F(**)
	rights to Brimbal					A	A	A
	lefts from Brimbal					*F(1.32)	*F(1.30)	*F(1.12)
College Rd. at Parker Brothers Option I	lefts from P.B.					D		
	rights from P.B.					A		
	lefts to P.B.					A		
College Rd. at Parker Brothers Options II & III	lefts from P.B.						A	E
	rights from P.B.						A	A
	lefts to P.B.						A	A
College Rd. at Dunham Rd. Option 111	lefts to P.B.							A
	rights to Dunham Rd.							A
	lefts to College							A

KEY

\*F = total failure. On the average, no acceptable gaps will ever occur. If a vehicle is waiting for an acceptable gap, it will wait for the entire peak hour. The vehicle must therefore accept a gap which is unsafe.

(X.XX) = volume/capacity ratio

(\*\*) = degree of failure which is beyond the limits of the analysis equations

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AM-PEAK-HOUR SERVICE-LEVEL SUMMARY

CTPS

TABLE

3-1

		1987						
Description	Movement	1982 Base Year	No Collage	No Collage	With Collage/With Local Growth			
			No Local Growth	+ Local Growth	Existing Network	Network Option I	Network Option II	Network Option III
Brimbal Ave. at Dunham Rd.	all of Dunham Rd	E	E	*F (1.26)	*F (**)	D		*F (**)
	Brimbal lefts to Dunham	A	A	A	A	A	A	A
	Brimbal lefts to Rts. 128	A	A	A	A	A	A	A
Sohier Rd. at Rte. 128 NB	lefts to Sohier Rd.	E	E	E	*F (1.07)	*F (1.07)	*F (1.07)	*F (1.07)
	rights to Rte. 128	A	A	A	A	A	A	A
	lefts to Brimbal Ave.	A	A	A	A	A	A	A
Rte. 128 SB at Brimbal	lefts from Rte. 128	D	D	D	E	E	E	D
	rights from Rte. 128	A	A	A	A	B	B	A
Rte. 128 NB at Brimbal	lefts to Brimbal	*F (1.98)	*F (2.06)	*F (2.12)	*F (2.71)	*F (4.96)	*F (4.64)	*F (2.07)
	rights to Brimbal	A	A	A	A	B	B	B
	lefts from Brimbal	A	A	A	A	A	A	A
College Rd. at Brimbal	lefts to Brimbal					E	E	E
	rights to Brimbal					*F (1.03)	*F (1.03)	A
	lefts from Brimbal					A	A	A
College Rd. at Parker Brothers Option I	lefts from P.B.					D		
	rights from P.B.					A		
	lefts to P.B.					A		
College Rd. at Parker Brothers Options II & III	lefts from P.B.						A	A
	rights from P.B.						A	A
	lefts to P.B.						A	A
College Rd. at Dunham Rd. Option III	lefts to P.B.							A
	rights to Dunham Rd.							A
	lefts to College							A

KEY

\*F = total failure. On the average, no acceptable gaps will ever occur.  
If a vehicle is waiting for an acceptable gap, it will wait for the  
entire peak hour. The vehicle must therefore accept a gap which is  
unsafe.

(X.XX) = volume/capacity ratio

(\*\*) = degree of failure which is beyond the limits of the analysis equations

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PM-PEAK-HOUR SERVICE-LEVEL SUMMARY

**CTPS**

TABLE

3-2

Recall from chapter 2 of this report that severe capacity deficiencies have been defined in terms of two levels. The first (service level E) is when acceptable gaps in traffic exist but the average vehicle would be required to wait beyond 35 seconds for one. The second (service level F) occurs when, on the average, an insufficient number of acceptable gaps occur and the average vehicle accepts gaps which are below safe levels.

In the PM peak, each of the locations cited above would continue to have capacity problems under all scenarios, with the intersection of Brimbal Avenue and Dunham Road added to the list. This additional location is in the first level of failure, where the average vehicle has long waits for acceptable gaps in traffic. At the intersection of Route 128 northbound at Brimbal Avenue, the left turns to Brimbal are beginning to move into the second level of failure where the average vehicle will not find an acceptable gap in traffic and will be forced to accept a gap of  $5\frac{1}{2}$ -6 seconds or less rather than the safe minimum gap of 6.2 seconds for this type of movement.

Tables 3-3 and 3-4 indicate the expected vehicle-queue lengths that would occur based on the service levels listed in Tables 3-1 and 3-2. It should be noted that these queue lengths are averages and that the maximum queue length could easily exceed twice the amount of the average.

When total failure occurs (signified by "\*F" in the tables), it is difficult to estimate queue length because the gap accepted by the average vehicle is unknown.

In addition to the intersection analysis, a merge analysis for Route 128 was performed. There are three vehicle-merge locations at the Brimbal Avenue interchange. The locations of these merge points are illustrated in Figure 3-1. The service levels of the merge points for the peak hours, under the various scenarios reviewed, are shown in Table 3-5.

In the base year there is one merge location which is at capacity. The Brimbal Avenue northbound on-ramp to Route 128 southbound is at service level E in the AM peak hour. This is due to two factors. The first is that there is no acceleration lane for merging traffic. Secondly, there is a stop sign at the top of the ramp. Given that there is no acceleration lane and vehicles merge onto Route 128 from a dead stop, a very large gap in traffic is needed before a vehicle should attempt to enter the Route 128 flow. This entrance ramp carries the same volume (400-450) in both the AM and PM peaks, but in the AM peak southbound-Route-128 volume at this point exceeds 2,300 while the PM-peak volume is under 1,200--thus the difference between service level E in the AM and B in the PM peak.

Description	Movement	1982 Base Year	1987					
			No College No Local Growth	No College + Local Growth	Existing Network	Network Option I	Network Option II	Network Option III
Brimbal Ave. at Dunham Rd.	all of Ounham Rd	0	0	0	*F	0	0	1
	Brimbal lefts to Ounham	0	0	0	0	0	0	0
	Brimbal lefts to Rte. 128	0	0	0	0	0	0	0
Sohier Rd. at Rte. 128 NB	lefts to Sohier Rd.	*F	*F	*F	*F	*F	*F	*F
	rights to Rte. 128	0	0	0	0	0	0	0
	lefts to Brimbal Ave.	0	0	0	2-3	2-3	2-3	2-3
Rte. 128 SB at Brimbal	lefts from Rte. 128	2-3	2-3	2-3	*F	*F	*F	2-3
	rights from Rte. 128	0	0	0	1-2	0	0	0
Rte. 128 NB at Brimbal	lefts to Brimbal	2-3	2-3	*F	*F	1-2	1-2	1-2
	rights to Brimbal	0	0	0	0	*F	*F	*F
	lefts from Brimbal	0	0	0	0	0	0	0
College Rd. at Brimbal	lefts to Brimbal					*F	*F	*F
	rights to Brimbal					0	0	0
	lefts from Brimbal					*F	*F	*F
College Rd. at Parker Brothers Option I	lefts from P.B.					0		
	rights from P.B.					0		
	lefts to P.B.					0		
College Rd. at Parker Brothers Options II & III	lefts from P.B.						0	1-2
	rights from P.B.						0	0
	lefts to P.B.						0	0
College Rd. at Ounham Rd. Option III	lefts to P.B.							0
	rights to Ounham Rd.							0
	lefts to College							0

\*F = total failure. On the average, no acceptable gaps will ever occur. If a vehicle is waiting for an acceptable gap, it will wait for the entire peak hour. The vehicle must therefore accept a gap which is unsafe. Queue length has not been estimated, because the average gap accepted is unknown.

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AVERAGE AM-PEAK-HOUR  
VEHICLE-QUEUE LENGTH

**CTPS**

TABLE

3-3

Description	Movement	1987						
		1982 Base Year	No College No Local Growth	No College + Local Growth	With College/With Local Growth			
					Existing Network	Network Option I	Network Option II	Network Option III
Brimbal Ave. at Dunham Rd.		3-5	3-5	*F	*F	0-1	0-1	0-1
	all of Dunham Rd	0	0	0	0	0	0	0
	Brimbal lefts to Dunham	0	0	0	0	0	0	0
	Brimbal lefts to Rte. 128	0	0	0	0	0	0	0
Sohier Rd. at Rte. 128 NB		1-2	1-2	1-2	*F	*F	*F	*F
	lefts to Sohier Rd.	0	0	0	0	0	0	0
	rights to Rte. 128	0-1	0-1	0-1	0-1	0-1	0-1	0-1
	lefts to Brimbal Ave.	0	0	0	0	0	0	0
Rte. 128 SB at Brimbal		0	0	0	0-1	0-1	0-1	0
	lefts from Rte. 128	0	0	0	0	0	0	0
	rights from Rte. 128	0	0	0	0	0	0	0
		0	0	0	0	0	0	0
Rte. 128 NB at Brimbal		*F	*F	*F	*F	*F	*F	*F
	lefts to Brimbal	1	1	1	1	1-2	1-2	1-2
	rights to Brimbal	0	0	0	0	0	0	0
	lefts from Brimbal	0	0	0	0	0	0	0
College Rd. at Brimbal						0-1	0-1	0-1
	lefts to Brimbal					*F	*F	0
	rights to Brimbal					0	0	0
	lefts from Brimbal					0	0	0
College Rd. at Parker Brothers Option I						1-2		
	lefts from P.B.					0		
	rights from P.B.					0		
	lefts to P.B.					0		
College Rd. at Parker Brothers Options II & III							0	0
	lefts from P.B.						1	0
	rights from P.B.						0	0
	lefts to P.B.						0	0
College Rd. at Dunham Rd. Option III								0
	lefts to P.B.							1
	rights to Dunham Rd.							0
	lefts to College							0

\*F = total failure. On the average, no acceptable gaps will ever occur. If a vehicle is waiting for an acceptable gap, it will wait for the entire peak hour. The vehicle must therefore accept a gap which is unsafe. Queue length has not been estimated, because the average gap accepted is unknown.

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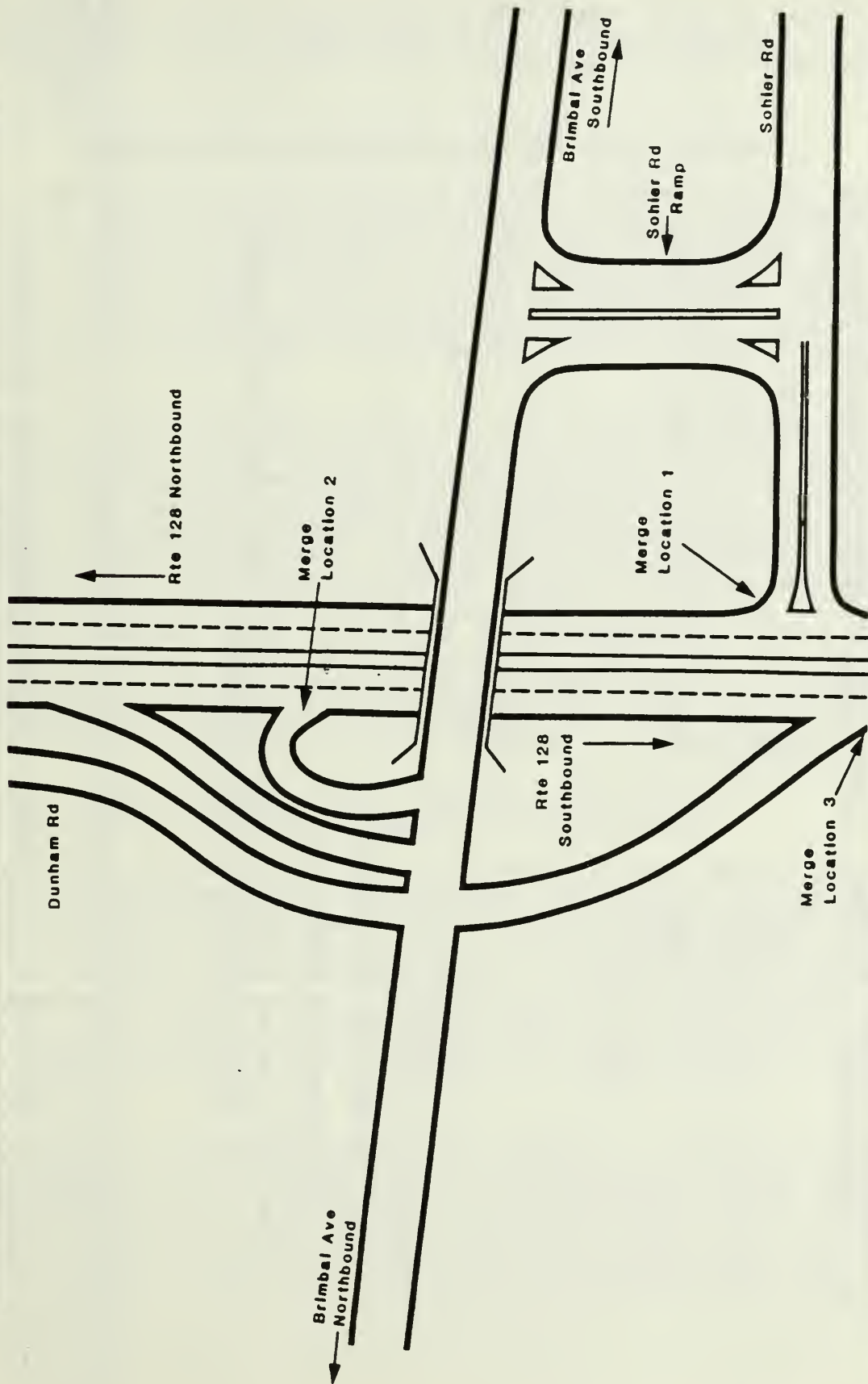
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AVERAGE PM-PEAK-HOUR  
VEHICLE-QUEUE LENGTH

CTPS

TABLE

3-4



CTPS

FIGURE

3-1

ROUTE 128 MERGE-AREA LOCATIONS ANALYZED

NOT TO SCALE

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Merge Location Number	1982 Base Year	1987		
		No College + Local Growth	With College/With Local Growth	
			Network Option I	Network Option II
			Option III	

1	A(C)	A(C)	A(D)	A(D)
2	E(B)	E(B)	E(F*)	E(A)
3	B(B)	B(B)	B(B)	B(B)

X = AM peak hour service level

(X) = PM peak hour service level

\*F = Total Failure - On the average, no acceptable gaps will occur in traffic.  
In the two instances here, the V/C ratio is 1.4.1.

North Shore Community College Traffic-Impact Study	CTPS	
	TABLE	
Technical Report 50 November 1985	ROUTE 128 VEHICLE-MERGE SERVICE LEVELS	
	3-5	

The Brimbal Avenue/Route 128 interchange does not appear to have the capability of supporting a significant increase in traffic volumes, as documented by the base-year service-level analysis.

### 3.2 FORECAST-YEAR CONDITIONS WITHOUT THE COLLEGE

If neither the college nor the Parker Brothers expansion is built, there does not appear to be any change in service level at any location in either the AM or PM peak hours. In chapter 2 it was estimated that traffic volumes would increase a total of 1-2% from 1982 to 1987. This estimate was based on the population and employment projections for the area, which show a population change of +0.1% and an employment change of +4.0% for this same period.

Should Parker Brothers complete its expansion plans, there are two locations that would be impacted. The first is the Dunham Road/Brimbal Avenue intersection. Dunham Road does not appear to have the ability to support additional traffic in the PM peak hour. The second location is at the Route 128 northbound off-ramp at Brimbal Avenue. Left turns at this location to Brimbal Avenue northbound were shown in chapter 2 to have an average vehicle delay of 45 seconds in the AM peak (based on actual observations). Any additional volume would make the average vehicle delay 1 to 2 minutes or more. The minimal increase in traffic volume and substantial potential impact attributed to the expansion of Parker Brothers demonstrates how sensitive the area is and how inadequate the interchange's geometrics are.

### 3.3 TRAFFIC IMPACTS ATTRIBUTED TO THE COLLEGE

With the only college access via Dunham Road, Dunham Road would carry approximately 9,300 vehicles per average weekday. Vehicles exiting Dunham Road would be forced to accept gaps in traffic of 5-5½ seconds during the AM peak. There would be total intersection failure in the PM peak hour. For this reason, various site-access alternatives have been proposed for the college. It was never the intent to access the college by Dunham Road; however, it was included in the analysis as a reference point to facilitate an understanding of the various access options and their impacts.

In each of the three site-access options, it appears that a traffic signal is warranted for the intersection created by the access road with Brimbal Ave. This is demonstrated in the capacity analysis, which indicates that the left turns to and from the access road will be over capacity. Also, the traffic volumes were checked against the Manual of Uniform Traffic Control

Devices.<sup>1</sup> The volumes appear to meet signal warrant 1, the minimum vehicle volume warrant.

The traffic volumes served by the access road do not appear to warrant more than one travel lane in each direction under any of the access-road scenarios. The average daily traffic served by the access road ranges from 8,700 for Option I to 5,200 for Option III. These figures represent those used for the 1987 analysis. Looking beyond 1987 at 2005, with the possibility of an additional Parker Brothers expansion, the access road would carry a maximum of 10,000 vehicles. A two-lane facility would still be sufficient to handle this load. Any intersection created as part of, or with, the new access facility should be wide enough to support two approach lanes in each direction. This will prevent through moving vehicles from being impeded by turning vehicles.

Another consideration with regard to the geometrics of the access road has to do with the bridge span. The Massachusetts Department of Public Works should be consulted to determine if any plans are under consideration to reconstruct or widen Route 128. The span should be wide enough to accommodate possible Route 128 expansion.

#### Option I

Under this option, all traffic destined for the new college, Parker Brothers, or businesses east of Parker Brothers on Dunham Road would be required to use the new access road. The section of Dunham Road between Brimbal Avenue and the Beverly Times would be a separate segment from that segment east of the new access road.

This option has several positive impacts on the area. It greatly reduces the volume of traffic on Dunham Road. Under this option, Dunham Road would carry approximately 1,100 vehicles per day, compared to 3,100 in 1982. The intersection of Brimbal Avenue and Dunham Road would operate at service level D in the PM peak hour (the worst hour of the day for this location), compared to service level E under the existing conditions.

Another key benefit occurs at the intersection of Brimbal Avenue and the Route 128 northbound ramps/Sohier Road ramp. All traffic destined for either Parker Brothers, the college, or businesses on Dunham Road east, coming from Route 128 northbound, would take a right turn here. In the base year these vehicles would make a

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<sup>1</sup>U. S. Department of Transportation, Federal Highway Administration, Manual of Uniform Traffic Control Devices for Streets and Highways, Washington, D.C.: U. S. Government Printing Office, 1978.

left and access their destinations via the existing Dunham Road. From both safety and capacity perspectives it is better to make a right turn than a left. Left turns are made against traffic from two opposing directions, while rights have only one direction to contend with. The service-level analysis indicates that the left turns to Brimbal Avenue at this intersection operate at service levels E and F during peak hours in the base year and under each of the access road scenarios. Option I does not improve this situation, but it does minimize the impacts of the college on this intersection.

A final benefit of this option is that it would upgrade the intersection of the access road and Brimbal Avenue to safely accommodate high volumes of vehicles turning into the college, rather than spread these turns out over several locations.

On the negative side, Route-128-southbound traffic destined for the new college or Parker Brothers would be required to make a left onto Brimbal Avenue and travel south to the new access road. Presently, Parker Brothers traffic can make a right here. This negative impact tends to offset the advantages gained at the Route 128 northbound/Sohier Road ramp/Brimbal Avenue intersection.

All traffic leaving the college or areas served by eastern Dunham Road would utilize the new access road. This is a benefit from the perspective that all the traffic will load Brimbal Avenue at a single point and this point could be signalized. On the negative side, traffic destined for Route 128 southbound would merge onto Route 128 at merge location 2. This would cause this merge point to operate at service level F in the PM peak hour.

#### Option II

This option is similar to Option I. The only difference is that trips destined for Parker Brothers or areas east of Parker Brothers on Dunham Road may use Dunham Road. Vehicles exiting these areas are required to exit via the new access road as in Option I.

This option provides one benefit over Option I. It would allow some of the Route 128 southbound traffic destined for Parker Brothers or points east thereof to make a right turn on Brimbal Avenue from Route 128 rather than a left. This helps the Brimbal Avenue/Route 128 southbound intersection; however, it hurts Dunham Road. In Option I, Dunham Road would carry 1,100 vehicles per day; under this option it would carry nearly 1,400. However, Dunham Road would still carry fewer vehicles daily than the 3,100 it presently serves.

Aside from this one aspect, the service levels and delays under Options I and II are nearly identical. Under this option there is still a problem for traffic leaving the college destined for Route 128 southbound. Merge location 2 is at service level F.

### Option III

Under Option III, Dunham Road is severely impacted. This option would increase the traffic on Dunham Road by 1,500 vehicles per day (48%) over the base year. The capacity analysis has demonstrated that in the base year the Brimbal Avenue/Dunham Road intersection is operating beyond acceptable levels. This option would force this intersection into service level F.

This option does provide relief for the Route 128 merges, especially for Brimbal Avenue northbound to Route 128 southbound. Once a vehicle manages to get out of Dunham Road in the PM peak, it will have an easy time merging with the Route 128 southbound traffic.

### Summary

In an attempt to provide some further insight into which option is the most viable, several comparisons were developed. First is a comparison of the Dunham Road volumes under each scenario, as follows.

TABLE 3-6

#### DUNHAM ROAD VOLUME BY SCENARIO

<u>Year</u>	<u>Scenario</u>	<u>Average Weekday Traffic</u>
1982	Base Case	3,090
1987	No College/No Local Growth, Existing Network	3,090
1987	No College/+ Local Growth, Existing Network	3,770
1987	+ College/+ Local Growth, Existing Network	9,320
1987	+ College/+ Local Growth, Access Option I	1,090
1987	+ College/+ Local Growth, Access Option II	1,358
1987	+ College/+ Local Growth, Access Option III	4,558

In this comparison, Option I provides the most benefits to Dunham Road. Option II does well also.

The second comparison is that of traffic volumes on Brimbal Avenue at the Route 128 underpass, as follows.

TABLE 3-7  
BRIMBAL AVENUE VOLUME BY SCENARIO

<u>Year</u>	<u>Scenario</u>	<u>Average Weekday Traffic</u>
1982	Base Case	13,740
1987	No College/No Local Growth, Existing Network	13,959
1987	No College/+ Local Growth, Existing Network	14,339
1987	+ College/+ Local Growth, Existing Network	17,381
1987	+ College/+ Local Growth, Access Option I	16,527
1987	+ College/+ Local Growth, Access Option II	16,259
1987	+ College/+ Local Growth, Access Option III	12,619

Option III has the greatest impact here, reflecting the fact that trips from Parker Brothers and the new college would travel down Dunham Road to reach Route 128 southbound or Brimbal Avenue northbound. Otherwise, these vehicles would travel down the new access road and take a right turn onto Brimbal Avenue.

From the traffic-flow perspective, it would be most appropriate to direct as many vehicles as possible to exit via the access road and make optimum use of a signal installed there. This would tend to rule out Option III, since Dunham Road would carry more traffic than it does in the base year. Many vehicles may attempt to use Dunham Road rather than the new road to leave the college or Parker Brothers. This use of Dunham Road to a degree undermines the use of the new access road. It would not appear beneficial to increase traffic on Dunham Road since it has been documented to have problems in the base year.

#### 3.4 POTENTIAL MEASURES TO IMPROVE TRAFFIC FLOW

Ultimately the interchange should be reconstructed to current engineering standards, but this raises a larger issue since many

of the Route 128 interchanges in this area have similar problems and the area should be looked at as a whole. But given that the reconstruction of this interchange and others in this area are long-range prospects at best, it would be appropriate to develop interim measures to address existing problems. Two corrective measures which could be implemented to improve traffic flow in the area are summarized below.

1. Widen Brimbal Avenue to four lanes from the Route 128 underpass south to approximately 250-500 feet south of the proposed Brimbal Avenue/college-access road intersection.
2. Provide signing on Route 128 southbound that would encourage as many vehicles as possible to move into the left lane, thus providing a better situation for vehicles on the Brimbal Avenue northbound entrance ramp to Route 128 southbound.

These measures are relatively minor in scope. Because of existing geometrics and land use, measures with greater impact would require major right-of-way acquisition.

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#### 4 TRAFFIC IMPACTS AT THE ENON STREET/DODGE STREET AND LAUREL STREET/DODGE STREET INTERSECTIONS

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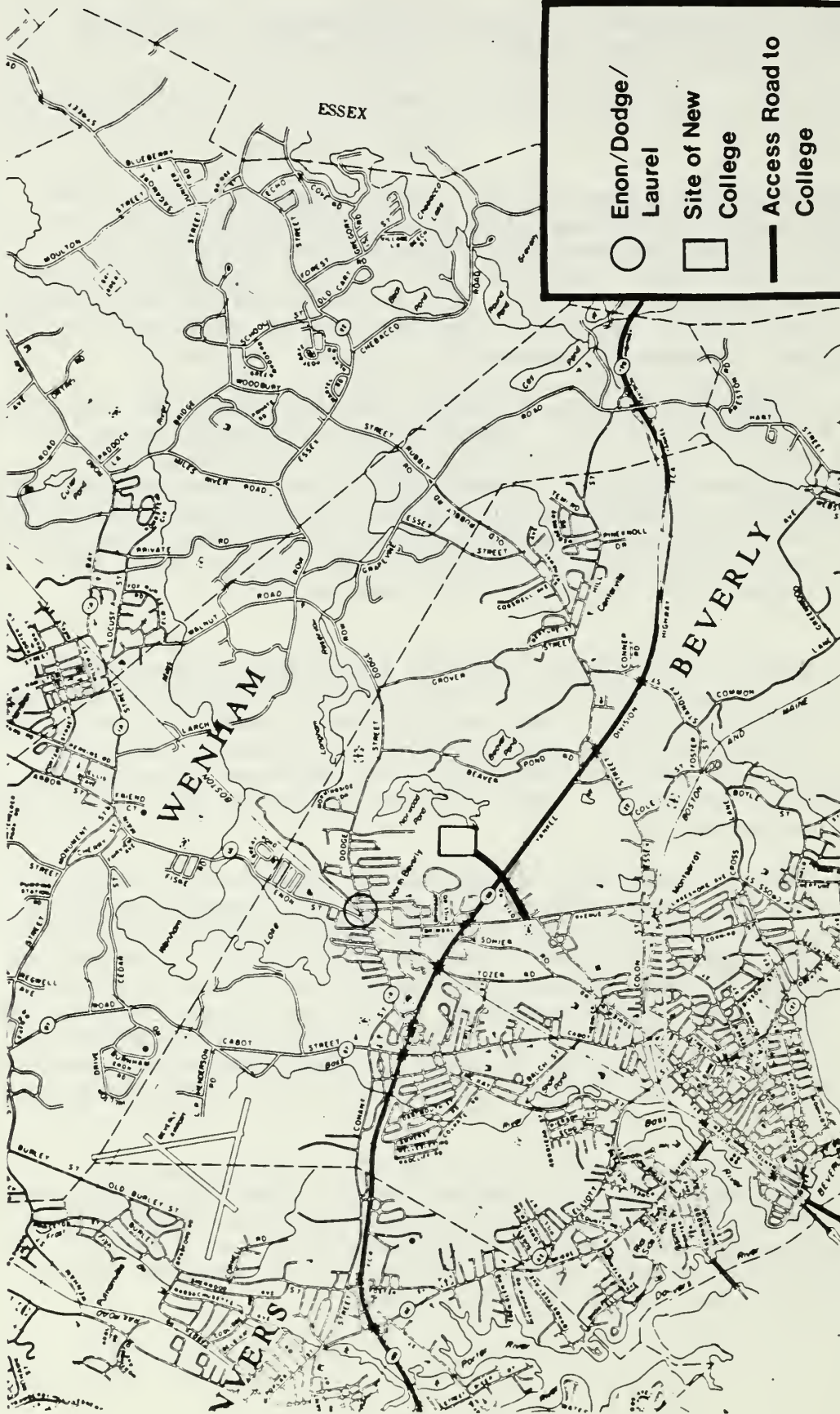
The Enon Street/Dodge Street/Laurel Street/Dodge Street intersections are located several miles north/northwest of the future site of the North Shore Community College (see Figure 4-1). These intersections have been included in this analysis because they handle large traffic volumes and serve as major crossroads in the northern part of Beverly, and many trips destined for the college may pass through this area.

The geometric configurations of these intersections are depicted in Figures 4-2, 4-3, and 4-4. Also shown in these figures are the turning movements estimated for several development scenarios. Most of the traffic volumes shown were developed using traffic counts made available to CTPS by the Town of Beverly. These counts were taken by the consultant to the town, Louis Berger and Associates, Inc. Several of the volumes were estimated using volumes estimated in previous sections of this report.

The type of analysis conducted and the techniques employed for this analysis are consistent with the analysis conducted in the other parts of this study. The analysis was conducted for a 1982 base year, for 1987 without the college and without the Parker Brothers expansion, and for 1987 with the college and with the Parker Brothers expansion. The analysis was performed under each of these three scenarios.

Based on the traffic analysis developed in chapters 1 and 2 of this report, it has been estimated that on the average weekday approximately 290 vehicle trips will be generated by the college that travel on Brimbal Avenue, north of Route 128. This volume represents three percent of the traffic on this road, and five percent of the total trips generated by the college. During the AM peak hour, traffic generated by the college will account for two percent of the traffic which uses the Enon/Dodge and Laurel/Dodge intersections, and 0.5 percent of the total PM-peak-hour traffic.

As can be seen in Tables, 4-1, 4-2, and 4-3, this area has problems in the base year and the problems worsen by 1987. However, the incremental increase in average vehicle delay attributed to the college (and Parker Brothers expansion) traffic appears negligible in most cases. Overall, the impacts of the college on this area appear to be minimal.



**CTPS**

**FIGURE**

4-1

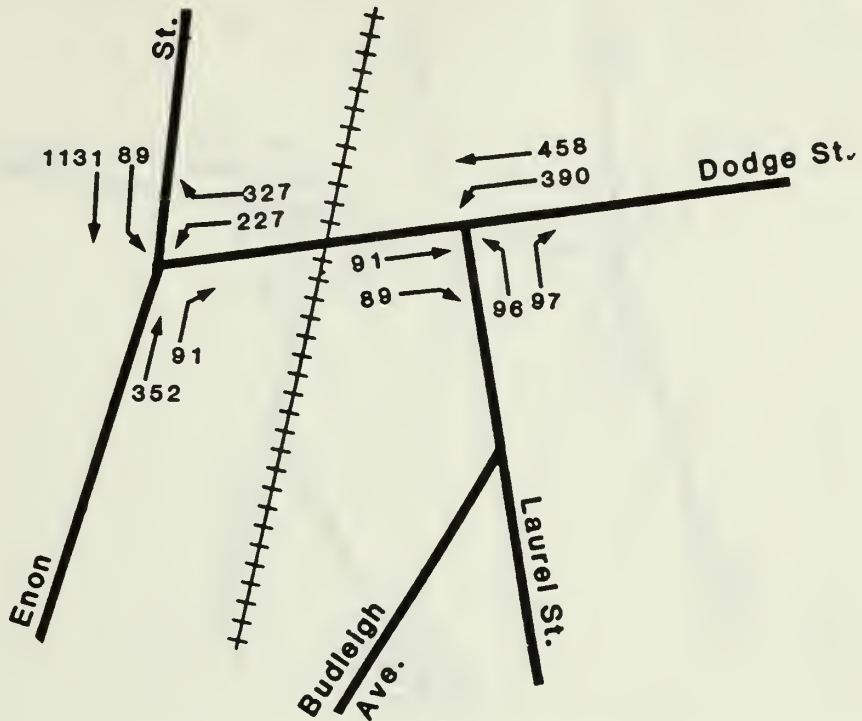
LOCATION OF ENON/DODGE/LAUREL INTERSECTIONS

1" = Approx. 6 Mi.

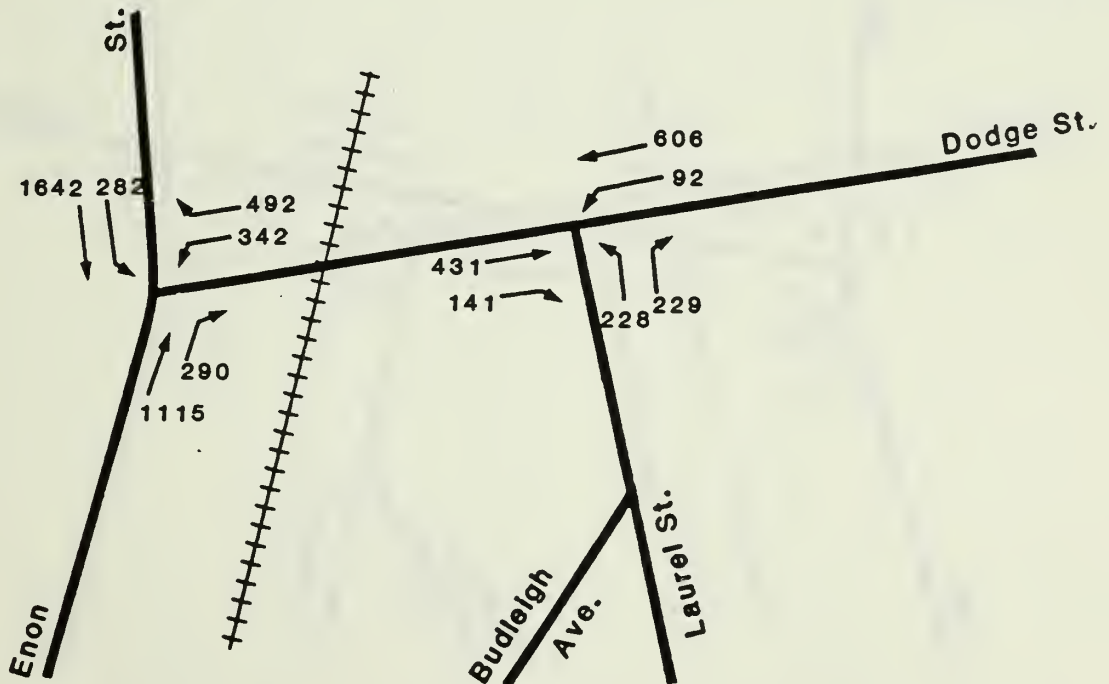
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# AM PEAK



# PM PEAK



NOT TO SCALE

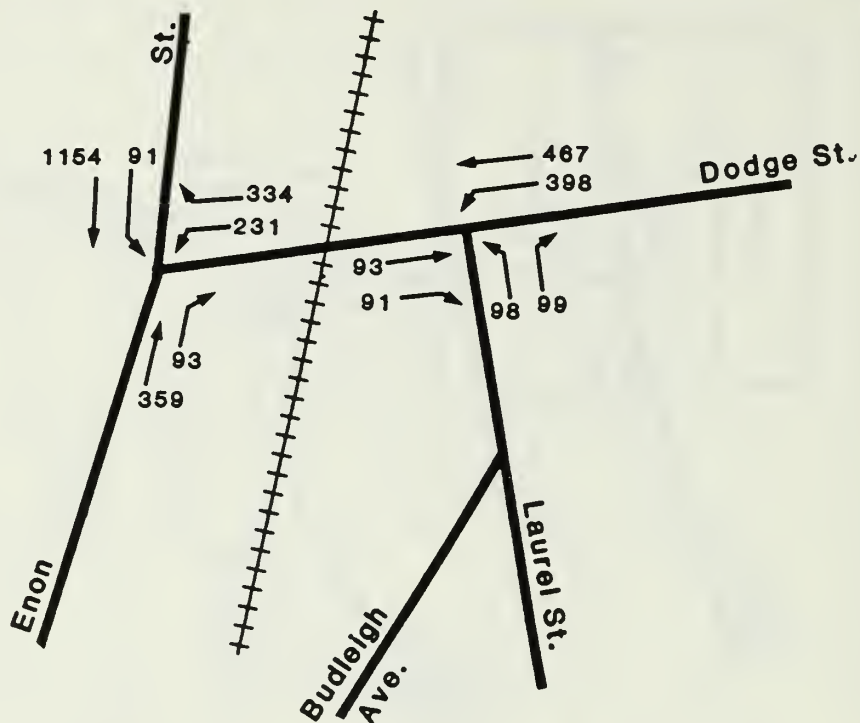
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ENON/DODGE/LAUREL INTERSECTIONS  
TURNING-MOVEMENTS SUMMARY  
BASE YEAR  
1982 AM AND PM PEAKS

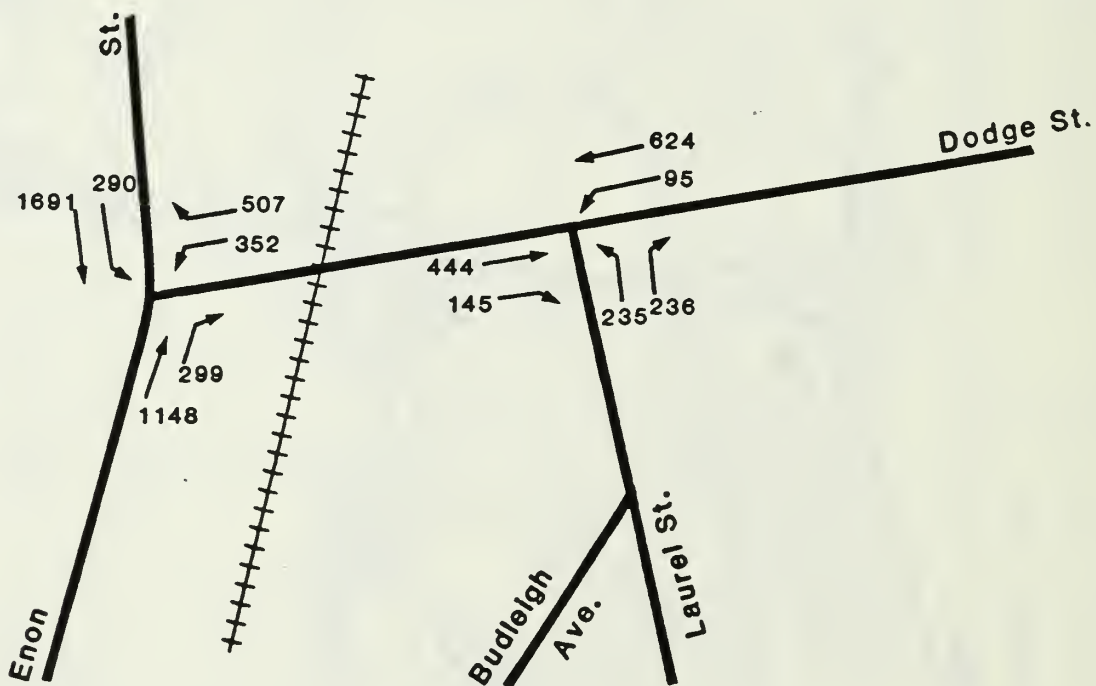
**CTPS**

FIGURE  
4-2

# AM PEAK



# PM PEAK



NOT TO SCALE

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November 1985

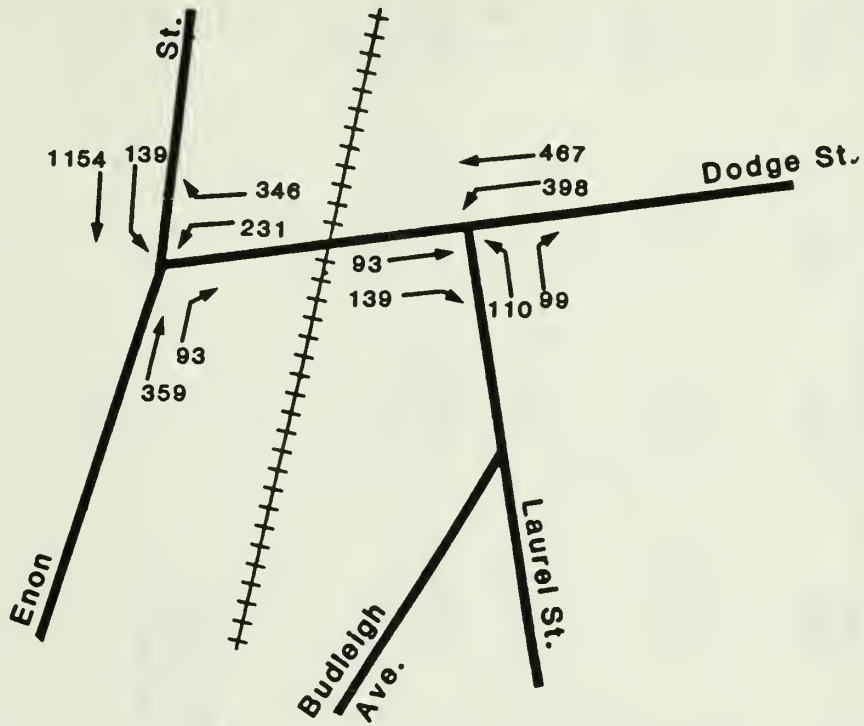
ENON/DODGE/LAUREL INTERSECTIONS  
TURNING-MOVEMENTS SUMMARY  
WITHOUT COLLEGE/  
WITHOUT PARKER BROTHERS EXPANSION  
1987 AM AND PM PEAKS

**CTPS**

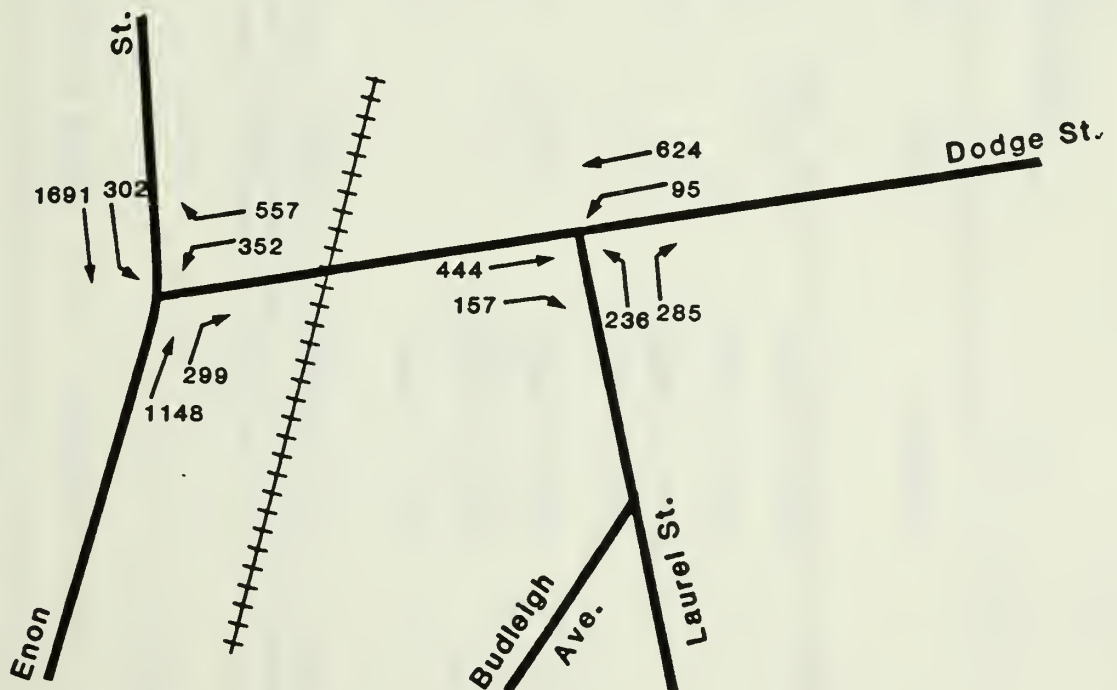
**FIGURE**

4-3

# AM PEAK



# PM PEAK



NOT TO SCALE

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ENON/DODGE/LAUREL INTERSECTIONS  
TURNING-MOVEMENTS SUMMARY  
WITH COLLEGE/WITH 50,000-SQ.-FT.  
PARKER BROTHERS EXPANSION  
1987 AM AND PM PEAKS

**CTPS**

**FIGURE**

4-4

<u>Description</u>	<u>Movement</u>	1982 Base		1987 No College No Parker Brothers Expansion		1987 With College With Parker Brothers Expansion	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Enon Street at Dodge Street	lefts to Enon	F*(4.90)	F*(B)	F*(5.29)	F*(B)	F*(8.47)	F*(B)
	rights to Enon	B	F*	B	F*	C	F*(2.72)
	lefts to Dodge	A	E	A	E	A	F*(1.01)
Dodge Street at Laurel Street	lefts to Dodge	F*(1.04)	F*(2.61)	F*(1.06)	F*(2.94)	F*(1.36)	F*(3.57)
	rights to Dodge	A	C	A	C	A	C
	lefts to Laurel	A	A	A	A	A	A

\*F = Total Failure - On the average, no acceptable gaps will ever occur.  
If a vehicle is waiting for an acceptable gap, it will wait for the entire peak hour. The vehicle must therefore accept a gap which is unsafe.

(X.XX) = Volume/Capacity Ratio

(B) = Degree of failure beyond the limits of the analysis equations

North Shore Community College Traffic-Impact Study	CTPS	
	TABLE 4-1	
Technical Report 50 November 1985	ENON/DODGE/LAUREL INTERSECTIONS PEAK-HOUR SERVICE-LEVEL SUMMARY	

<u>Description</u>	<u>Movement</u>	1982 Base		1987 No College No Parker Brothers Expansion		1987 With College With Parker Brothers Expansion	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Enon Street at Dodge Street	lefts to Enon	F*	F*	F*	F*	F*	F*
	rights to Enon	10-15	F*	10-15	F*	15-19	F*
	lefts to Dodge	0-10	35+	0-10	35+	0-10	F*
Dodge Street at Laurel Street	lefts to Dodge	F*	F*	F*	F*	F*	F*
	rights to Dodge	0-10	15-19	0-10	15-19	0-10	15-19
	lefts to Laurel	0-10	0-10	0-10	0-10	0-10	0-10

\*F = Total Failure (Volume/Capacity is greater than 1)

North Shore Community College Traffic-Impact Study	ENON/DODGE/LAUREL INTERSECTIONS PEAK-HOUR AVERAGE VEHICLE DELAY (IN SECONDS/VEHICLE)		CTPS TABLE 4-2
	Technical Report 50 November 1985		

Description	Movement	1982 Base		1987 No College No Parker Brothers Expansion		1987 With College With Parker Brothers Expansion	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Enon Street at Dodge Street	lefts to Enon	F*	F*	F*	F*	F*	F*
	rights to Enon	1	F*	1	F*	1-2	F*
	lefts to Dodge	0	2-5	0	3-5	0	F*
Dodge Street at Laurel Street	lefts to Dodge	F*	F*	F*	F*	F*	F*
	rights to Dodge	0	1	0	1	0	1
	lefts to Laurel	0-1	0	0-1	0	0-1	0

\*F = Total Failure (Volume/Capacity is greater than 1)

North Shore Community College Traffic-Impact Study	ENON/DODGE/LAUREL INTERSECTIONS PEAK-HOUR AVERAGE VEHICLE-QUEUE LENGTH		CTPS TABLE 4-3
	Technical Report 50 November 1985		

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## 5 THE IMPACT OF COLLEGE CONSTRUCTION ON LOCAL TRAFFIC

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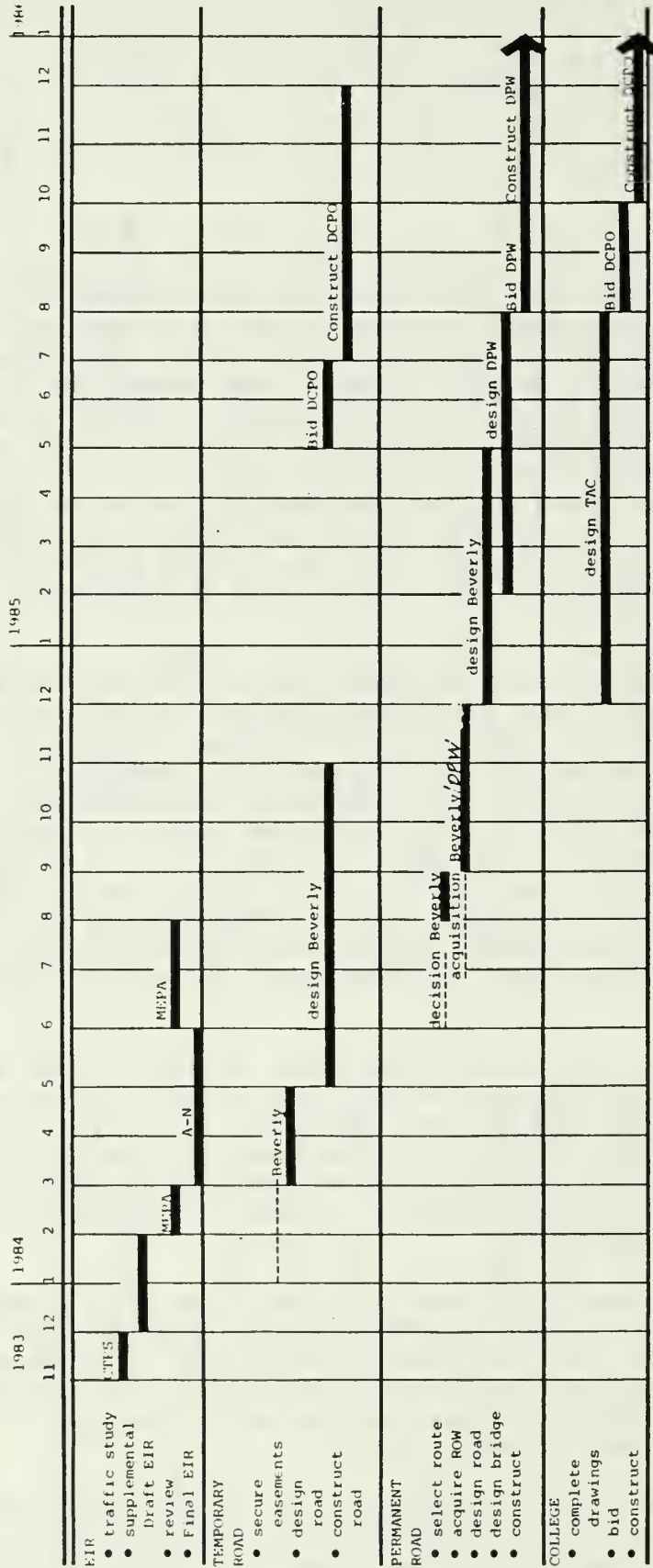
Given the geometrics and traffic volumes of many of the roads around the college site, and the fact that the new access road will not be completed before construction of the college begins (see Figure 5-1), it is anticipated that construction-equipment movement will impede existing traffic flows. The magnitude of these impacts hinges primarily on the site-access point. Several access options have been proposed. The first option was to provide access along the narrow right-of-way off Dodge Street. The second option was to extend one of the residential streets off Brimbal Avenue to the site. A third option is access off Dunham Road. The fourth option involved direct access from Route 128. The only viable option appears to be access from Dunham Road.

Ideally, to evaluate the construction equipment impacts on existing traffic flow, the traffic volumes (specifically truck-traffic volumes) which enter the site would be estimated by hour of the day. Estimation of the total truck-traffic volume which will enter the site over a period of time can be accomplished based on the construction schedule and quantity of materials needed. However, it is difficult to distribute these volumes by day of week and then by hour of the day. It should also be noted that the analysis in previous sections of this study shows that many of the area's critical movements are at capacity in peak hours and that, therefore, the area is very sensitive to the hour of the day during which additional volumes will be destined for the college site.

It does not appear to be a reasonable approach to try to estimate the amount of traffic generated by the college construction and then distribute this traffic to various hours of the day. These hourly volumes may be too speculative to be useful. Additionally, the analysis techniques available are not useful in estimating the impacts of additional traffic volumes at locations which are already over capacity.

Instead, the analysis methodology used involved the determination of the hours of the day which could absorb additional traffic volume. The quantities of the acceptable additional volumes were then identified. The construction contractor could then schedule work accordingly and possibly provide police assistance at appropriate time periods and intersections.

The analysis conducted in chapter 2 shows that in the 1982 base year many turning movements are at capacity in the peak hours. Construction equipment accessing the college site from the south



Anderson-Nichols (A-N)  
City of Beverly (COB)  
Central Transportation Planning Staff (CTPS)  
Division of Capital Planning and Operations (DCPO)  
Department of Public Works (DPW)  
The Architects Collaborative (TAC)  
Mass. Environmental Protection Agency (MEPA)

Chart Courtesy of DCPO

North Shore Community College Traffic-Impact Study

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CTPS

CONSTRUCTION SCHEDULE

FIGURE

5-1

via Route 128 to Dunham Road would take a right off Route 128 northbound, a left onto Sohier Road, and a left onto Brimbal Avenue. The left at Sohier Road is at service level A in both the AM and PM peak hours. The second left is the critical movement: it is at service level E in the AM peak hour and F in the PM. After traversing a short distance of Brimbal Avenue, vehicles would make a right turn onto Dunham Road. Vehicles making this right can do so easily in terms of delay attributed to other traffic. However, the geometrics of the Dunham Road/ Brimbal Avenue intersection are poor and would present problems for a semi-tractor trailer. A semi unit could not negotiate this turn if a vehicle were egressing from Dunham Road. The semi would need to use the Dunham Road egress lane to safely negotiate the turn.

For northbound vehicles exiting the college site the only problem would be to cross Brimbal Avenue from Dunham Road. Egressing from Dunham Road appears to be a problem only in the PM peak hour.

Accessing the college site appears to be less of a problem from the north than from the south. The right turn from Route 128 southbound to Brimbal Avenue is at service level A in both the AM and PM peak hours. Coming from Route 128 southbound would necessitate a right turn onto Dunham Road similar to that necessitated by access from the south, and therefore subject to the same geometric constraints.

For vehicles egressing Dunham Road to Route 128 northbound, a left turn from Dunham Road must be made which is slightly more difficult than a through movement. Other movements associated with getting to Route 128 northbound do not appear to have capacity problems in either of the two peak hours, as analyzed earlier.

To summarize, there appear to be three problem areas associated with construction equipment accessing the college site. The first is left turns from the Route 128 northbound Sohier Road ramp to Brimbal Avenue northbound. The second problem is associated with vehicles leaving Dunham Road, particularly in the PM hours. The third is a geometric problems at the Dunham Road/Brimbal Avenue intersection, particularly for large trucks.

In an attempt to address the former two problems, two tables have been prepared. Table 5-1 reflects the service levels provided by hour of the day at the two locations, Table 5-2 reflects the excess capacity at each location by time of day.

As shown in Table 5-1, egressing from Dunham Road does not appear to be a problem throughout most of the day. The PM peak hour appears to be the only period when Dunham Road is at capacity. At the Sohier Road/Route 128 northbound ramp at Brimbal Avenue, the situation is different. The left turns to Brimbal Avenue demonstrate capacity problems throughout the majority of the day.

Dunham Road at  
Brimbal Ave.

Brimbal Ave. at  
Sohier Rd. Ramp/Rte. 128 N.B.

Brimbal Ave.

Sohier Rd. Ramp

Southbound  
Lefts

Lefts to  
Brimbal Ave.

Lefts from  
Brimbal Ave.

Dunham  
Road

Period

7-8	C	A	A	E	A	A
8-9	C	A	A	F	A	A
9-10	A	A	A	C	A	A
10-11	B	A	A	C	A	A
11-12	C	A	A	E	A	A
12-1	C	A	A	F	A	A
1-2	C	A	A	D	A	A
2-3	B	A	A	F	A	A
3-4	C	A	A	F	A	A
4-5	E	A	A	F	A	A

North Shore Community College  
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CURRENT SERVICE LEVEL BY TIME OF DAY  
FOR MOVEMENTS THAT WILL BE CRITICAL  
DURING COLLEGE CONSTRUCTION

CTPS

TABLE  
5-1

Excess Capacity  
in Passenger Vehicles/Hour

Period	Exiting Site via Dunham Road	Entering Size: Lefts from Sohler Rd. Ramp to Brimbal Ave. N.B.	Excess Capacity in Trucks/Hour for Most Critical Movement
7-8	254	27	14
8-9	277	0	0
9-10	437	247	124
10-11	398	235	118
11-12	243	95	48
12-1	207	0	0
1-2	239	111	56
2-3	386	0	0
3-4	202	0	0
4-5	14	0	0

NSCC Traffic-  
Impact Study

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CURRENT EXCESS CAPACITY BY  
TIME OF DAY FOR MOVEMENTS  
THAT WILL BE CRITICAL  
DURING COLLEGE CONSTRUCTION

**CTPS**

TABLE  
5-2

Table 5-2 shows the excess capacity available at each location for the critical movements. For example, at Dunham Road between 7:00 and 8:00 AM, the excess capacity is shown to be 254 passenger vehicles. This indicates that Dunham Road can serve an additional 254 passenger vehicles between 7:00 and 8:00 AM over what it presently serves. The sum of the existing volume and 254 additional vehicles would put this location at capacity, or on the border between service levels E and F.

By reviewing Table 5-2 it can be seen that the best time for construction equipment to access the college site is between 9:00 AM and noon. Access/egress during other periods of the day may necessitate the use of police officers for traffic control.

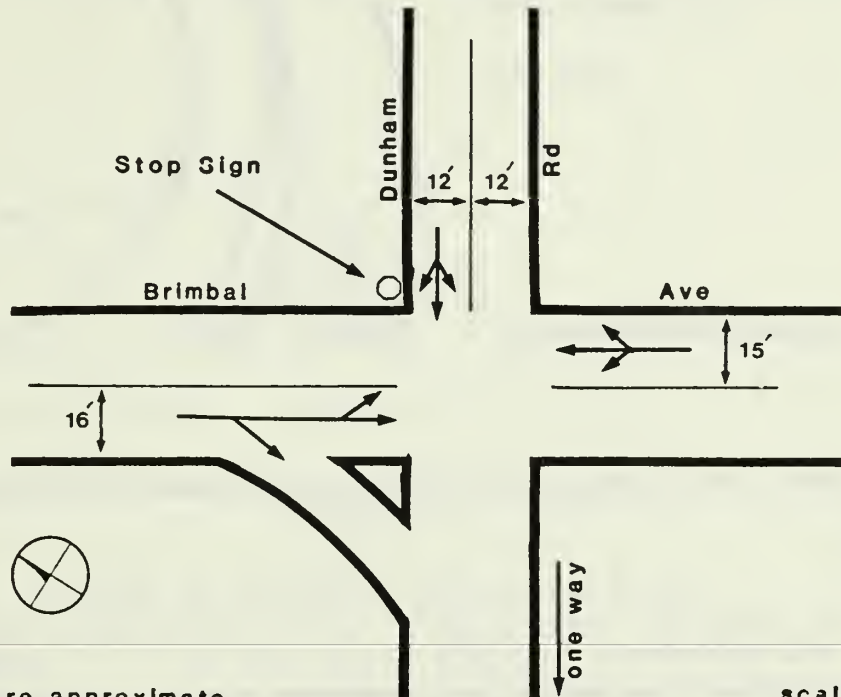
## APPENDIX A

### Existing Intersection Geometrics



LOCATION: #1

DESCRIPTION: Brimbal Ave at Dunham Rd

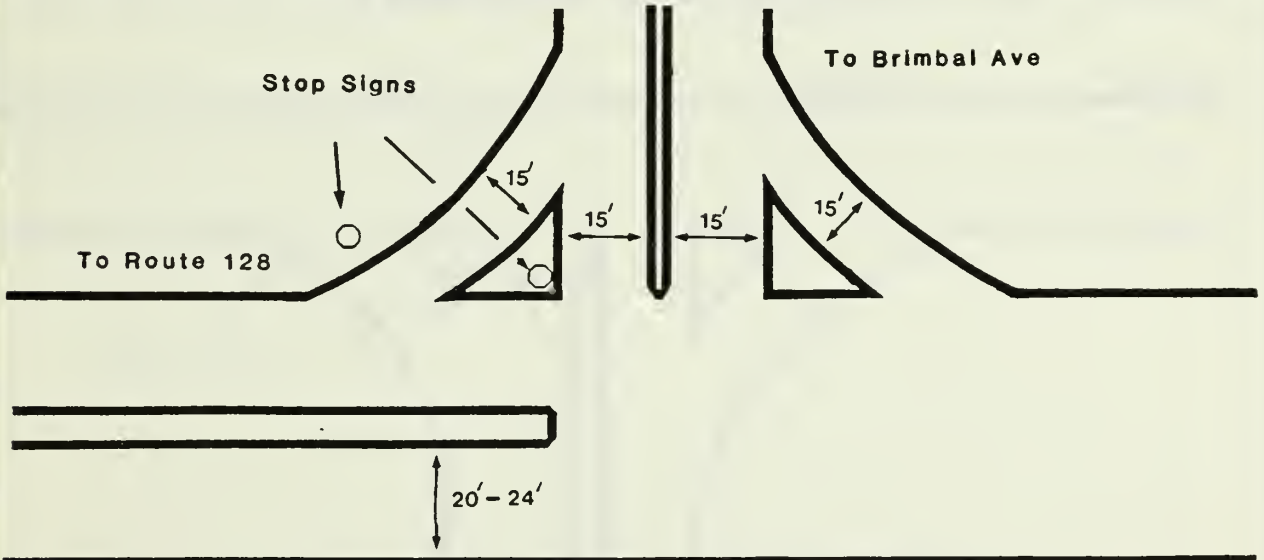


all widths are approximate

scale 1" = 40'

LOCATION: #2

DESCRIPTION: Sohler Rd at Route 128 Northbound



all widths are approximate

scale 1" = 40'

NSCC Traffic-  
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EXISTING INTERSECTION GEOMETRICS

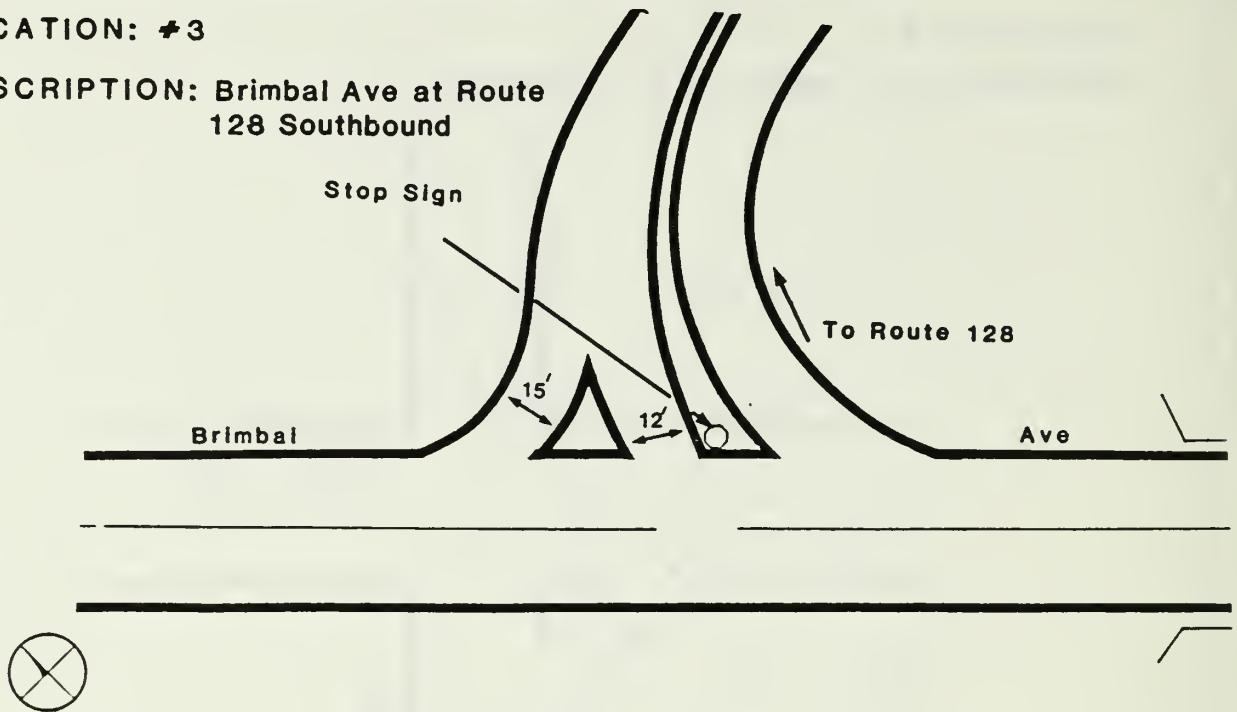
**CTPS**

FIGURE

A-1a

LOCATION: #3

DESCRIPTION: Brimbal Ave at Route 128 Southbound

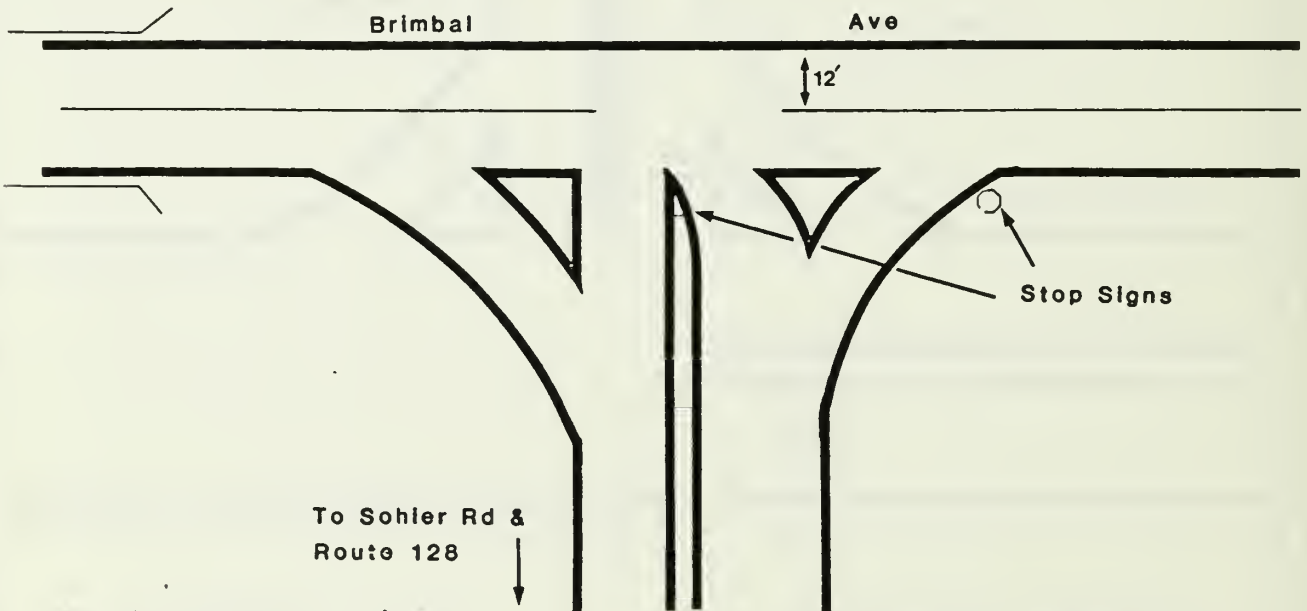


all widths are approximate

scale 1" = 40'

LOCATION: #4

DESCRIPTION: Brimbal Ave at Route 128 Northbound



all widths are approximate

scale 1" = 40'

NSCC Traffic-  
Impact Study

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EXISTING INTERSECTION GEOMETRICS

**CTPS**

FIGURE

A-1b

## APPENDIX B

Review of Comments Received by the  
Mass. Executive Office of Environmental Affairs  
on the Draft EIR/EA



REVIEW OF COMMENTS RECEIVED BY THE EOEA ON THE DRAFT EIR/EA

Source:

Police Department  
City of Beverly, Massachusetts  
(letter to EOEA, June 1, 1983)

Question/Comment:

"Dunham Road is a narrow residential street that is not designed to handle any more traffic than it already does."

Response:

Given that in an urban area, the capacity of a roadway is often defined by the capacity of the area's intersections, the analysis in this document focused on defining the capacities of the intersections which compose the Route 128/Brimbal Avenue interchange and other intersections directly impact by this project. The analysis is summarized in Tables 3-1 and 3-2 on pages 44 and 45, respectively, of this document. The analysis shows that the Dunham Road approach to the Brimbal Avenue/Dunham Road intersection is operating at service level C in the AM peak and E in the PM peak, in the 1982 base year.

Source:

Metropolitan Area Planning Council  
110 Tremont Street  
Boston, Massachusetts  
(letter to EOEA, April 30, 1982)

Question/Comment:

"Plans for access to the site appear to be very uncertain at this time. In one section of the ENF it is stated that an access road will be constructed between the site and Dunham Road. In another section it is stated that the connection will be made to Brimbal Avenue at some point south of Route 128. Further information concerning the alignment of this access road, along with an analysis of the impacts of the newly generated traffic on Route 128 and the nearby residential areas, should be thoroughly discussed in the EIR.

Response:

Three access options to the site of the new college have been identified and were analyzed as part of the draft EIR. These three access options are discussed in section 1.4 on pages 13-20. Figure 2-6 on page 34 indicates the traffic volumes which have been estimated to be generated by the college. The traffic analysis which estimates the impacts of the college traffic on local roads is presented in chapters 2 and 3 of this report.

Source:

Metropolitan Area Planning Council  
110 Tremont Street  
Boston, Massachusetts  
(letter to EOEa, June 20, 1983)

Question/Comment:

"Although it is stated in the EOEa Scoping Letter that CTPS was to provide a traffic analysis of the proposed project, no such analysis was performed by CTPS. The analysis that was instead performed, apparently by the consultant, provides inadequate documentation and limited data concerning the impacts and assumptions made with respect to traffic. Although a set of traffic forecasts for the various alternatives for 1985 and 2005 are provided, these forecasts are not analyzed to objectively evaluate impacts. Volume/capacity ratios are not provided, as required in the Scoping Letter, nor is a Level of Service analysis. Furthermore, no information is provided concerning number of future trips generated by the proposed College development, peaking characteristics, or future trip distribution on the various roadways serving the study area. Overall, the section dealing with Traffic/Access Impacts provides only a subjective analysis which is insufficiently qualified to make a clear comparison of the various alternatives.

"In the section describing Access Road Design Status it states that no decisions have been made at this stage concerning the dimensions of the new access road. Either a 2 or 4 lane road is considered feasible. However, no information or analysis is provided concerning the desirability or potential impacts of these two options. Such information, made available at the EIR stage, would be useful in evaluating these options.

"Based on the EIR, it is not clear how long interim site access will be required. Will construction of a permanent access road be scheduled to coincide with the opening of the

campus? To what extent has coordination taken place with MDPW to assure that the interim access would not be required beyond the period of time required for construction of the campus?

"Although interim access from Route 128 is considered the "most feasible interim solution", no diagrams or maps of the former truck turnoff and the necessary traffic movements are provided. As a result, it is difficult to verify the EIR's conclusion. Of particular concern are possible safety hazards posed by this option."

Response:

With regard to the first comment, this report was prepared in order to complete the draft EIR, and the information cited above as being missing in the draft has been included in this document.

With regard to the second comment, the traffic volumes which the new access road could carry are between 8700 for Access Option I and 5200 for Option III in the 1987 forecast year. In the forecast year of 2005, the access road could be serving nearly 10,000 vehicles per day. The geometrics of the access road are discussed on page 52 of this document. Basically, the access road would be a two-lane facility with the intersection widened to two lanes in each direction.

With regard to the third comment, a schedule which illustrates the phasing of the college construction and that of the access road is included in chapter 5 of this report.

With regard to the fourth comment, site access for construction equipment has now been proposed to be via Dunham Road. See chapter 5 of this report for a discussion of site access during construction.

Source:

Local Citizen  
Beverly, Massachusetts  
(letter to EOEA, May 26, 1983)

Question/Comment:

"To put a road from the college to connect onto Brimbal Avenue is sheer madness. You are creating a monster of a problem that you will be unable to correct if you do this."

Response:

There is a real problem developing at the Brimbal Avenue interchange with Route 128 as evidenced by the service-level analysis. Measures to correct many of these problems are presented in section 3.4 of this document.

Source:

The Beverly Times  
Monday, June 20, 1984  
Editorial

Question/Comment:

"It appears to us that the permanent access plan does not go far enough. Solutions that employ Brimbal Avenue as the only access do not take into account future utilization and possible industrial expansion."

Response:

Future growth in the area is discussed in section 2.3 (page 23) of this document.

Source:

Local Citizen  
Beverly, Massachusetts  
(letter to EOE, June 22, 1983)

Question/Comment:

"Have you considered the impact of heavy construction trucks on any residential road during the construction period of NSCC."

Response:

The issue of construction equipment accessing the site of the new college is discussed in chapter 5 of this document.

Source:

Local Citizen  
Beverly, Massachusetts  
(letter to EOE, June 22, 1983)

Question/Comment:

"Did you ever take a traffic count when Varian employees leave at end of their working day or when the N.S. Music Theater matinees on Wednesday and Saturday leave?"

Response:

The traffic counts indicate that the worse time of day to exit the site will be between 4 and 5 PM. The traffic generated by the North Shore Music Theater is significant; however, it is not heavy for a continuous hour. The North Shore Music Theater has very pronounced traffic-peaking characteristics. Since within the 4-5 PM period the highest traffic volume moves through the area and since the traffic volume is heavy for the entire hour, that was the period selected as the PM peak hour.

Source:

Local Citizen  
Beverly, Massachusetts  
(letter to EOE, June 22, 1983)

Question/Comment:

"Have you researched the horrendous backup of traffic from all points at the No. Beverly R.R. Crossing & Dodge St."

Response:

This issue is addressed in chapter 4 of this document.

Source:

Public Hearing  
in Beverly on June 15, 1983 (page 25)

Question/Comment:

Now, Dunham Road, poor old Dunham Road. My gosh, how many do you think they can stand down there? You are going to be blocked off either this week or next week with the community music center college that takes place all summer long. If I lived on Dunham Road, there would be no way that I could possibly go home during the hours that this theatre is let out. It's made into a one-way street. Right at this particular time, I have been told by the residents as I walk that area that we have traffic coming down from our

industrial plan up on the top of Dunham Road, that comes by, and it's a hazard to get out of your own driveway. That road was never intended to take large trucks and to continue this kind of atmosphere."

Response:

Under Option I, all of the traffic generated by the North Shore Music Theater will be diverted to the access road. Under Options II and III there are fewer trips diverted. The new access road would handle the traffic load from the theater since it would be designed to handle the load of the new college and Parker Brothers traffic between 4 and 5 PM. The traffic problems associated with getting from the access road to Route 128 southbound are real. Measures which could be implemented to relax the problem are proposed in section 3.4.

Source:

Public Hearing  
in Beverly on June 15, 1983 (page 41)

Question/Comment:

"Brimbal Avenue and Dodge Street can't afford any more traffic."

Response:

Traffic impacts to this area are discussed in chapter 4 of this document.

Source:

Public Hearing  
in Beverly on June 15, 1983 (page 43)

Question/Comment:

"We had an impact study presented here in November, at which a representative from the State Highway Department got up and said, 'We are going to empty the traffic out onto Brimbal Avenue, but we are going to restrict everything to right-hand turns, so that it won't increase the traffic flow measurably.' I asked the gentleman in private that evening how in hell people could get downtown to Beverly Cove, to Gloucester, Magnolia, Manchester, you name it, without making a left-hand off Brimbal Avenue. He said, 'Oh, I never thought of that.' They still haven't thought of it."

Response:

There is a real problem for traffic leaving the college site destined for Route 128 southbound. The geometrics of the Brimbal Avenue/Route 128 interchange do not lend themselves to minor improvements. Short of reconstructing the interchange there do not appear any reasonably available measures which could be implemented to address this problem.

Source:

Public Hearing  
in Beverly on June 15, 1983 (page 49)

Question/Comment:

"Also, I guess it was Alderman Battistelli that commented about the problem of left turns coming off from Route 1A, for those people that are coming down from the Hamilton/Wenham/Ipswich area, and that maybe is out of the range of focus of the consultants that worked on this report. But I think he has a point; that that ought to be looked at very carefully to see what kind of protective measures can be taken to anticipate the extra turning."

Response:

This area is discussed in chapter 4 of this document.

Source:

Public Hearing  
in Beverly on June 15, 1983 (page 64)

Question/Comment:

"Then there is the railroad crossing at Dodge Street in North Beverly. That can't take any more traffic at any time. North Beverly is just saturated with all kinds of traffic."

Response:

This area is discussed in chapter 4 of this document.

Source:

Public Hearing  
in Beverly on June 15, 1983 (page 65)

Question/Comment:

"You had an electric counter out last year on Dunham Road,  
and how many cars passed there the course of one day,  
average?"

Response:

Traffic counts taken at the Route 128/Brimbal Avenue inter-  
change are shown in Figure 2-2 on page 24.



